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for the Behavioral and Social Sciences

Research Report 1696

The Human Dimensions of Battle Command: A Behavioral Science Perspective on the Art of Battle Command

Stanley M. Halpin
U.S. Army Research Institute

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In response to a request from GEN Frederick F. Franks, Jr., (Ret.), then Commander of the U.S. Army Training and Doctrine Command (TRADOC), the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has undertaken a research initiative addressing the Art of Battle Command. This paper represents a first step. Here we examine what and how the behavioral science community can now contribute to improving effective Battle Command, what knowledge gaps we need to fill, and what future research requirements we anticipate based on our understanding of the likely impact of technology and the Army's changing role and missions.

We discuss our understanding of Battle Command, placing the concept into historical perspective to illuminate some of the issues. We identify and discuss the human dimensions of leadership and command, and begin an integration of relevant research findings and their implications for Battle Command. We suggest immediate applications of those findings to improve Battle Command today as well as discuss the relevance of today's research to Battle Command on tomorrow's battlefield.

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FOREWORD

For many years the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has explored situation assessment, decisionmaking, leadership, and other aspects of the behavior of operational commanders. In 1993, with the publication of the new field manual FM 100-5, Operations, Battle Command emerged as a concept that integrated a broad range of earlier writing on Army leadership and command and control. General Frederick F. Franks, Jr., then commander of the U.S. Army Training and Doctrine Command, challenged ARI to integrate its prior research in these areas to address the human dimensions of the Art of Battle Command. ARI formed a broad task force to identify and discuss its prior and ongoing research within the Battle Command context. This paper represents preliminary integration of that research.

These results were presented to GEN Franks on 6 August 1994 and subsequently to an Army-wide conference on Battle Command in November 1994.

ACKNOWLEDGMENTS

This report is the product of the U.S. Army Research Institute for the Behavioral and Social Sciences' (ARI) Battle Command Task Force that was created by Dr. Edgar M. Johnson, Director, ARI, in response to a broad tasking from GEN Frederick M. Franks, Jr., Commander, U.S. Training and Doctrine Command. The task force included:

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Several members of the staff of the Fort Leavenworth Research Unit (FLRU) provided significant assistance in editing and revising successive drafts of this report. However, Dr. Jon Fallesen of FLRU deserves particular attention for his many significant contributions to the content of the report.

THE HUMAN DIMENSIONS OF BATTLE COMMAND: A BEHAVIORAL SCIENCE PERSPECTIVE ON THE ART OF BATTLE COMMAND

EXECUTIVE SUMMARY

Requirement:

In October, 1993, the Commander of the U.S. Army Training and Doctrine Command, TRADOC, directed ARI to undertake a research initiative to address the human elements of battle command. The effort had the initial goals of identifying and explaining the "art of battle command," and determining how battle command can be formally transmitted and taught within Army institutions. In support of this effort, ARI undertook this exhaustive review of relevant previous research on the elements of battle command, i.e., decision making and leadership.

Procedure:

A task force of senior ARI researchers was assembled and given the task of identifying and reviewing all relevant ARI decision making and leadership research. Related research conducted elsewhere was also addressed, but little of relevance to the issue was identified. Findings and recommendations, which provided insights on the battle command process, were assembled into a briefing and presented to the Commander, TRADOC, in August 1994.

Findings:

This reexamination of previous research results in the context of the battle command concept led to a number of insights on the cognitive, social, and developmental factors which may impact battle command performance. For example, it was noted that real-world tactical decision making requires a battle commander to go beyond procedures to more complex thought processes, but that the Army has done little to teach people how to think.

Utilization of Findings:

The insights and recommendations from this paper were briefed to the Commander and the Deputy Commander, TRADOC, and subsequently formed the basis for a 3-day TRADOC/ARI workshop on Force XXI Battle Command (1-3 November, 1994). Based on feedback from those events, new course material was developed and implemented in a pilot project to determine the efficacy of teaching officers thinking skills. Additional projects have also been initiated in leadership assessment and development.

THE HUMAN DIMENSIONS OF BATTLE COMMAND: A BEHAVIORAL SCIENCE PERSPECTIVE ON THE ART OF BATTLE COMMAND

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THE HUMAN DIMENSIONS OF BATTLE COMMAND:
A BEHAVIORAL SCIENCE PERSPECTIVE ON THE ART OF BATTLE COMMAND

1. BACKGROUND: THE BATTLE COMMAND CONCEPT

> Battle Command: the art of battle decision making, leading, and motivating soldiers and their organizations into actions to accomplish missions. Includes visualizing current state and future state...formulating concept of operations...assigning missions; prioritizing and allocating resources; selecting critical time and place to act;...[making] adjustments during the fight.
>
> *FM 100-5: Operations. June, 1993*

INTRODUCTION

In response to a request from GEN Frederick F. Franks,Jr. (Ret.), then Commander of the US Army Training and Doctrine Command (TRADOC), the US Army Research Institute for the Behavioral and Social Sciences (ARI) has undertaken a research initiative addressing the Art of Battle Command. The 26 October, 1993 message from GEN Franks to the Director of ARI established as goals: (a) to identify and explain the "art of battle command;" and (b) to determine how battle command can be formally transmitted and taught within Army institutions. This paper represents a first step. Here we examine what and how the behavioral science community can now contribute to improving effective battle command, what knowledge gaps we need to fill, and what future research requirements we anticipate based on our understanding of the likely impact of technology and the Army's changing role and missions.

We will briefly discuss our understanding of battle command, placing the concept into historical perspective to illuminate some of the issues. We will identify and discuss the human dimensions of leadership and command, and begin an integration of relevant research findings and their implications for battle command. We will suggest immediate applications of those findings to improve battle command today as well as discuss the relevance of today's research to battle command on tomorrow's battlefield.

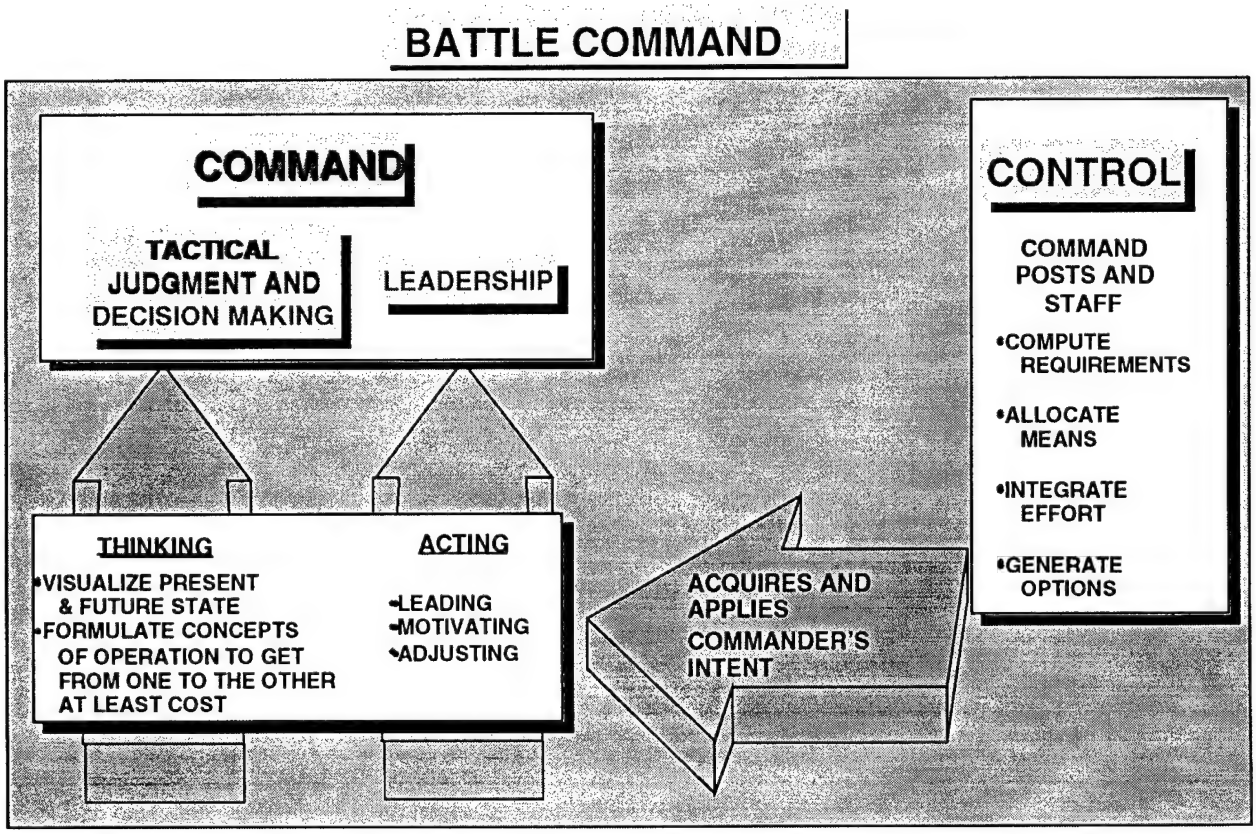
The 1993 version of the Army's capstone doctrinal publication, FM 100-5, *Operations*, reintroduced "battle command" into the Army lexicon. Even prior to the official release of the new FM 100-5 in the summer of 1993, the battle command concept had been dissected, discussed and debated in various briefings and concept papers; beginning in December 1993, *Military Review* has featured a series of articles with senior commanders' discussion of FM 100-5, including the battle command concept. The discussion is expected to continue for some time.

> ...battle command is about decisive victory -- dominating battle space -- whether it be some future Desert Storm or Fuertes Caminos....But battle command and battle space are evolving ideas; how must we understand them in the future?
>
> *GEN G. Sullivan, msg 8 Mar, 1994*

As spelled out in FM 100-5, battle command incorporates elements of command, control, and leadership. These functions and processes have been treated separately in Army doctrine, training, and leader development; their juxtaposition has caused considerable re-evaluation of these aspects of warfighting.

One clear result of this doctrinal shift is a renewed emphasis on the **human** element in command and control. Rather than focusing attention on command and control *systems*, the Army is placing more emphasis on the *battle commander.* The ARI battle command research initiative is one result of that renewed emphasis.

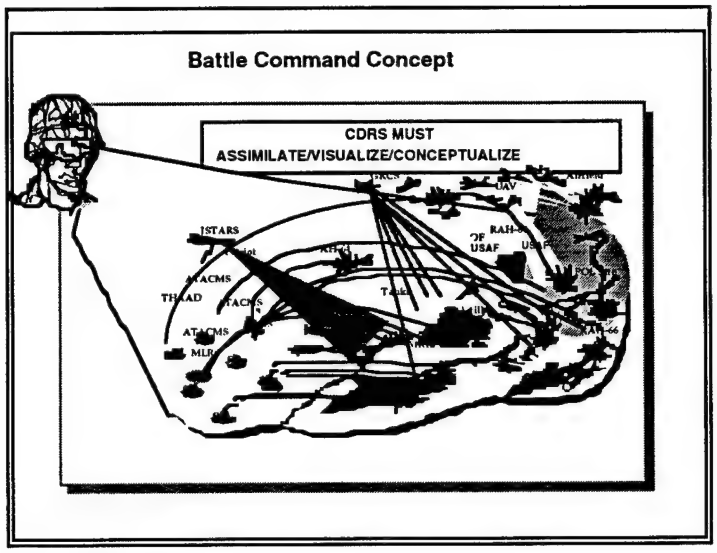
> In the world of the 21st century, the competitive advantage --the quantum competitive advantage-- will derive from the quantity, quality, and usability of information. The force of the 20th Century derived its architecture from 20th Century concepts, industrial age concepts of command and control. The architecture of Force XXI must derive from a far more robust, more versatile concept of information based battle command....Force XXI must be organized around information -- the creation and sharing of knowledge followed by unified action based on that knowledge which will allow commanders to apply power effectively....It is information-based battle command that will give us ascendancy and freedom of action -- for decisive results-- in 21st Century war and OOTW.
>
> *GEN G. Sullivan, msg 8 Mar, 1994*



BATTLE COMMAND

We must not be captured by our current command post fixations, large tactical staffs, nor our current programs to essentially make more efficient a worn out C2 engine. I have stopped using command and control...because it has too much excess intellectual baggage that I find gets in the way of discussing the art of command. We must be captured by a vision of battle command...

GEN Frederick M. Franks Jr., Feb. 22, 1993



General Franks' vision of battle command is introduced in FM 100-5 and expanded in a DRAFT Concept Paper first circulated for comments by the Battle Command Battle Laboratory (BCBL) in November, 1993. The roots of the concept can be traced to the rapid evolution of two critical aspects of Army operations: **mobility** and **information**.

Since the late 1950's the Army has developed and fielded information systems which were intended to provide the tactical commander and staff with sufficient, timely, quality information to support the constantly accelerating pace of command decision cycles. Each successive solution has been overwhelmed by staffs' voracious appetite for data and overrun by commanders' demands for flexible systems which can give them "the right information right now." There has been a growing frustration on the part of commanders at all levels with their inability to comprehend and effectively utilize the data and information which are available.

Neither doctrinal nor systems development efforts ignored the demand for more effective information processing. It was well understood that the increases in speed and capability of modern weapons systems had transformed the tempo and lethality of the battlefield. The AirLand Battle concepts first introduced in the 1976 version of FM 100-5 and greatly refined in the May 1986 version emphasized *initiative*, *agility*, *depth*, and *synchronization*. AirLand Battle also identified several key operating requirements, or imperatives; one of these imperatives was the need to anticipate events on the battlefield. The call to anticipate, to predict, and to develop contingencies is a recurring theme throughout the 1986 version of FM 100-5 and other doctrinal literature in the 1980's.

What was largely missing from the Army in the field was a set of tools, procedures, and systems which would allow the commander to effectively use available information to predict, to anticipate, to "see the battlefield".

Most division commanders would prefer to operate from a TAC CP, roaming around up front in a jeep, popping up in the nick of time at each *Schwerpunkt*, a genuine force multiplier...Yet... [the commander] raises his risks in prolonged stay away from Main. Until the Army finds out how better to communicate with the roving commander...he who commands from up front...relegates to subordinates crucial macrocosmic decisions on concentration of force, fire, maneuver or sustainment..

GEN Paul Gorman, A Command Post is Not a Place, unpublished paper, September, 1980.

Several factors limited the successful introduction of information systems' support for the Army field commander at a time when corporate executives were seeing their organizations transformed by the same technologies. One major stumbling block was the conviction that unit commanders must not be restricted to one place; they must have the freedom to roam the battlefield in order to personally feel and influence the battle.

To accommodate this belief, the Army has established as an explicit requirement that the information resident on the Army Tactical Command and Control System (ATCCS) be accessible from any node in a unit's ATCCS network. This requirement has had a cascading series of impacts on requirements for robust, secure, reliable data-capable communications links, and efficient multiple-node computer network architectures. Uniquely military concerns (e.g., security, EMP protection) added to the challenge for Army command and control systems developers.

As computer hardware and software capabilities and potential increased, so did the expectations of the commanders and their support staffs. Many field commanders and senior leaders became frustrated by the process and the interim products being fielded. One view frequently expressed by commanders and senior leaders is that the systems being developed were designed to support **staff** requirements; too little attention has been paid to the commanders. The battle command concept seeks to redress the balance between the human commander and the supporting information technologies by placing the primary focus squarely on the battle commander rather than on the systems which support the commander.

The commander cannot be a prisoner of a command post. He must retain access to the information he needs to command wherever he is on the battlefield.

DRAFT Battle Command Concept Paper, Nov, 1993

INFORMATION TECHNOLOGY

> We view command and control as essentially a human inference and decision-making process. While certainly supported by any number of information, decision, and "expert" systems, it remains essentially within the purview of the human commander to make decisions.
>
> *Andriole and Halpin, Information Technology for Command and Control, 1991.*

The battle command concept re-emphasizes the critical need for the **commander** to be the focal point, for the **commander** to be able to visualize the battlefield. The commander must have support from a battle command "system" which includes both the information technology components and the command staff. One of the issues we will come back to later in this paper is the role of the staff *viz. a viz.* the commander; here we briefly discuss the implications for battle command of the information technology available within the next few years.

> Battle command is commander-centered rather than staff-centered or, more accurately, command-centered rather than control-centered. Based on the vastly improved training over the past two decades, battle command is the logical extension of the Clausewitzian emphasis of the importance of the mind and will of the commander made possible by dramatic improvements in communications and the capabilities of units. ...The mind of the commander is still the key, but technology will eventually free the commander of the tyranny of the command post and the tether of the *pork chop* mike.
>
> *Maggart and Fontenot Mil Review Feb '94*

As discussed, the potential information flow in tactical and operational units has increased dramatically, a tribute both to advances in communications technology and to the proliferation of intelligence systems and effective down-links from both tactical and strategic systems. However, one of the remaining bottlenecks in command information processing is obtaining accurate, current information on the location and status of one's own subordinate units. As we have seen during realistic exercises in brigade and division command posts (CPs) , commanders' staffs are immersed in a sea of information being pushed and pulled into the CP.

Elaborate reporting procedures have been developed and refined to facilitate the periodic reports which "push" information to the CPs without over-burdening subordinate units; frequent communications within the "stovepipes" of specific functions (engineers, artillery, maneuver, etc.) seek to "pull" additional details from the subordinates so that staffs can maintain a complete, accurate picture of the battlefield.

The tactical map with graphic overlays remains the most common tool for integrating and displaying information received. The anticipated digitized tactical unit of the future will be equipped with Global Positioning System (GPS) equipment , cross-linked via a robust communications network, with automatic feed of a common picture of the battlefield from the lowest to the highest echelons. While the commander's expectations for the speed, accuracy, and reliability of tactical information may continue to outpace the ability of technology to meet the expectations, there is little question that the potential exists for the commander to have an accurate, almost-real-time view of the battlefield.

The implications for the **control** portion of command and control are profound. For example, we may be able to eliminate, or at least reduce reliance on, control measures such as boundaries between units. The process of "linking up" with adjacent units may no longer require face-to-face contact between flank units. Resupply vehicles can go where they are needed rather than to an arbitrary meeting point chosen to simplify navigation. However, for battle command, the benefits are less obvious.

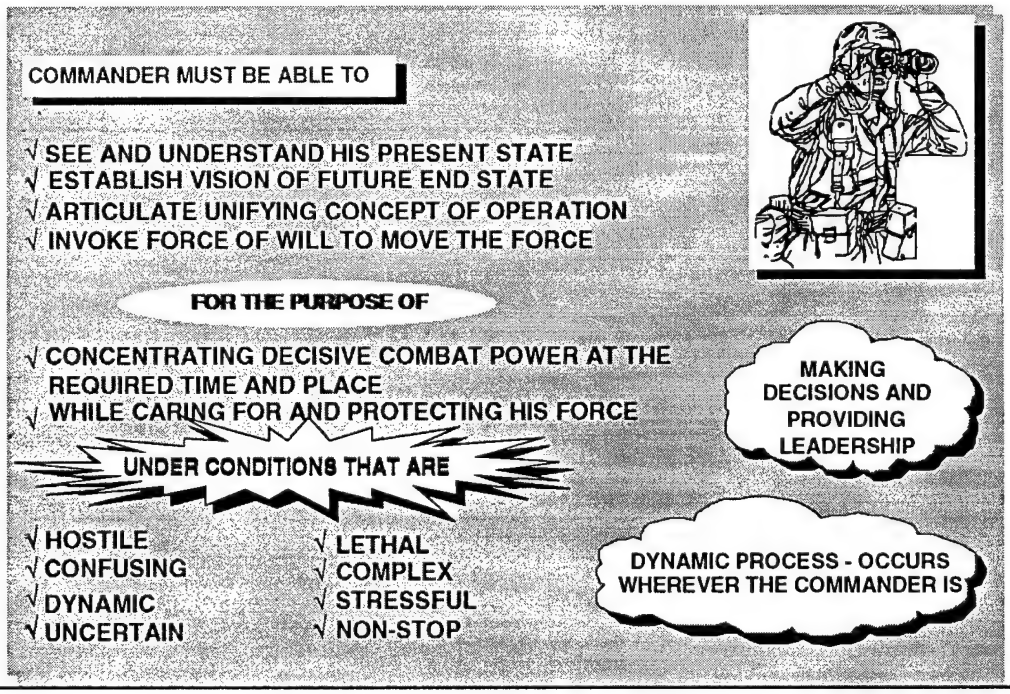
[In *Desert Storm*] ...if the Army had [Toffler's] 3rd wave technology, it did not yet have 3rd wave connectivity. For example, no system existed that linked national intelligence assets to tactical formations–thus enabling real-time transmission of critical combat information.

Maggart and Fontenot Mil Review Feb '94

The commander of a digitized unit will be liberated from the fixed command post (CP) of the past by information technology which provides for direct reception of vast quantities of information wherever the commander is on the battlefield. One danger is that commanders will be inundated with uninterpreted data in their mobile CPs, far removed from the staff officers who could help interpret the data and isolate critical items. Commanders have been faced with the choice of relying on staff interpretations, thereby losing a personal "intuitive feel" for battlefield conditions, or of immersion in the data flow within the Main CP, thereby losing the freedom to influence events with their personal presence. It is unclear whether the information technologies which provide the context for battle command will be able to support the information **processing** as well as the raw information requirements of the commander. It is clear that the role of the battle commander will be different from that of a commander within today's command and control system, and it seems likely that the demands on the battle commander will be increased rather than decreased.

Commanders relied heavily on people within their command to help them see and read the battlefield.

TRADOC PAM 525-100-2 Leadership and Command on the Battlefield: Battalion and Company, June, 1993



THE BATTLE COMMANDER

We have briefly sketched the battle command concept, a concept which derives from a re-examination of the age-old questions of how military commanders can effectively accomplish their mission, working through the efforts of the soldiers under their command and control. Battle command departs from the past in that the concept is explicitly crafted to deal with and take advantage of recent increases in battlefield mobility (and the consequent increases in battle tempo) and the snowballing applications of modern information technology throughout a commander's battle space. Underlying this battlefield context of battle command is the clear shift to a *command* as opposed to a *control* focus, a *commander* rather than a *staff* focus. In this section we look briefly at the picture which has been painted of the *battle commander*; we then turn to a discussion of the skills which a person would seem to require in order to fill that role.

The battle command concept envisions commanders who are empowered by information-age systems and modern weapons, who will have "better" information available, even in the absence of a large support staff. Battle commanders will operate under increased scope, intensity, and tempo of operations. The battle commanders' battle space will transcend that which is directly or immediately perceptible. They must be capable of: envisioning mission requirements; devising means for achieving them; infusing subordinates with understanding and a sense of mission; and otherwise implementing plans for mission requirements.

Operational success will require thorough understanding and commitment to the intent of the higher level commander, combined with the judgment and initiative to take appropriate independent action. The battle commander will be an active leader, not simply the director of a staff. Battle commanders will lead units which may be called upon to shift rapidly across the spectrum of operations, with a consequent shift in rules-of-engagement (ROE) which their soldiers must follow.

TABLE 1:
BATTLE COMMAND INCLUDES...

Battle Decision Making

>Visualize current state
>Visualize desired future state
>Formulate concept of operations
>Assign missions
>Prioritize and allocate resources
>Select critical time and place to act
>Know how/when to make adjustments during combat

Leading

>Train the Unit
>Recovery of the command after an operation

Motivating

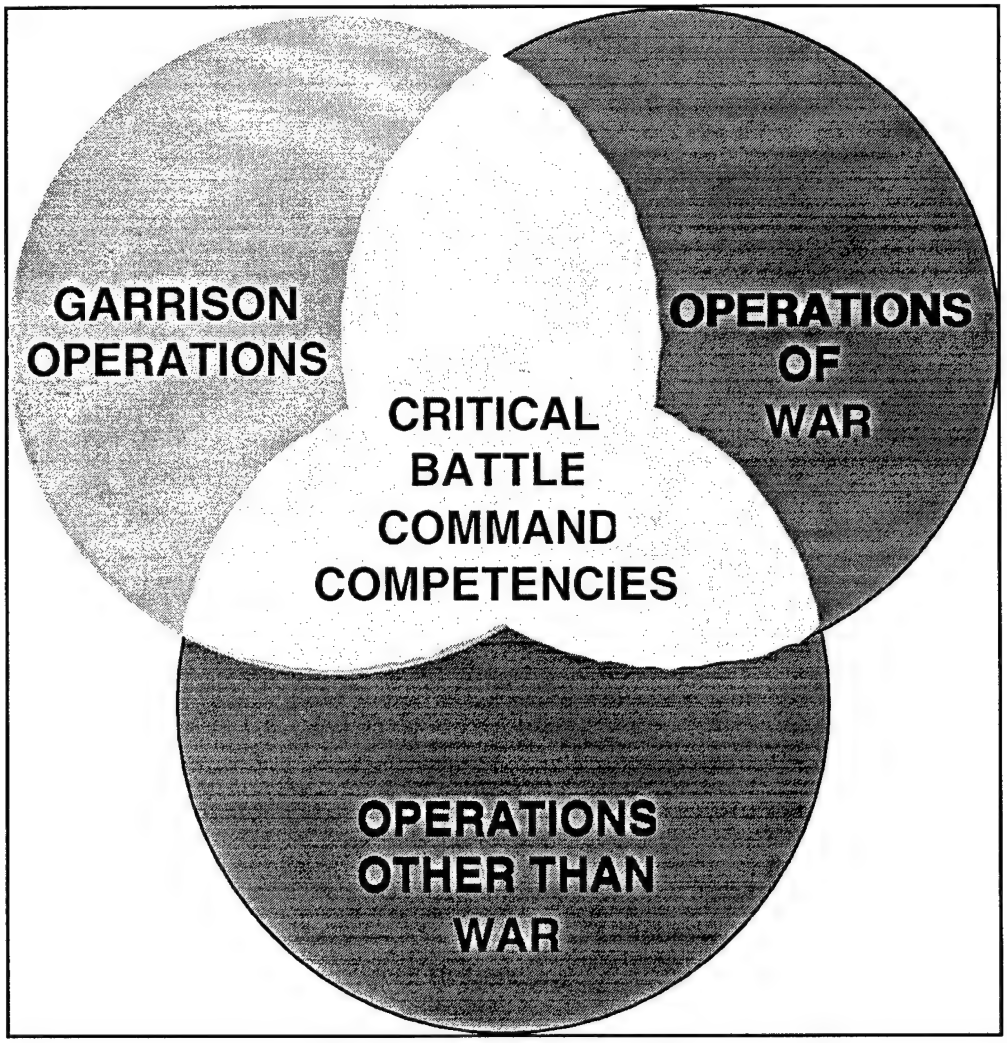
>Individual soldiers
>Organizations

Derived from DRAFT Battle Command Concept Paper, Nov, 1993

The battle command concept assumes that commanders will be competent decision makers and strong, innovative leaders, with the skills necessary to accomplish the tasks listed above in Table 1.

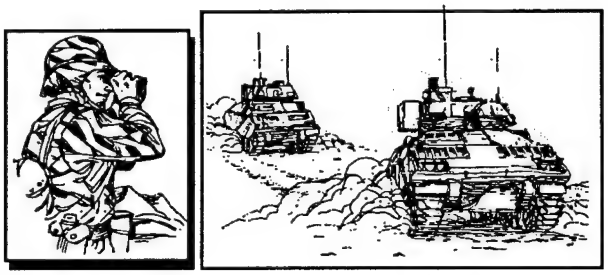
Battle command involves a combination of decision making and leadership skills, knowledge, and ability. It involves the effective application of that decision making and leadership expertise in a variety of situations, under a variety of time and organizational constraints. Battle command is not a solitary function, but in fact relies heavily on a "battle command support system" of people and information technology to provide the required information and to provide the control mechanisms which allow the commander to focus on command.

We found that battlefield leadership had to do with everything but equipment. Once the ability to communicate was established, the specific hardware pieces were far less important than what transpired on and through the lines
TRADOC PAM 525-100-1 Leadership and Command on the Battlefield: Operations JUST CAUSE and DESERT STORM, October, 1992



BATTLE COMMAND ISSUES FROM A BEHAVIORAL PERSPECTIVE

Examining the human dimension of battle command involves an analysis of the environment and its impact on battle commanders, and analysis of the relevant individual characteristics of battle commanders. The "environment" in this context includes the physical, but primary focus is on the information and organizational environments.



Relevant individual characteristics are principally those in the "cognitive" realm, those aspects of the person relating to his or her knowledge, skills, and abilities as they apply to battle command – decision-making and leadership.

From a behavioral science perspective, the issues to be considered in developing and implementing the battle command concept would **seem** to be the following:

>What information is required for the commander to make timely, effective tactical decisions?

>What is the best means of formatting and presenting the necessary information to the commander?

>What skills and abilities must the commander have to be able to effectively use the information provided?

>How is the process of leadership transformed by the availability of new technologies?

All of these questions reflect valid concerns. At some point specific answers to each of these specific questions may help to shape important decisions across the whole range of Doctrine, Training, Materiel, Organization, Leadership, and the Soldier (DTMOLS). However, such questions tend to obscure the complexities of human behavior. For example, the information particular commanders require to make a decision in a particular tactical situation will depend on many factors including: their confidence in their staff, in their information sources, and in their subordinate commanders; the extent of their background knowledge; the tactical risks; and the felt time pressure. The "ideal" type and amount of information, presented in a generic "optimum" format may not serve the needs of a particular commander in a particular situation.

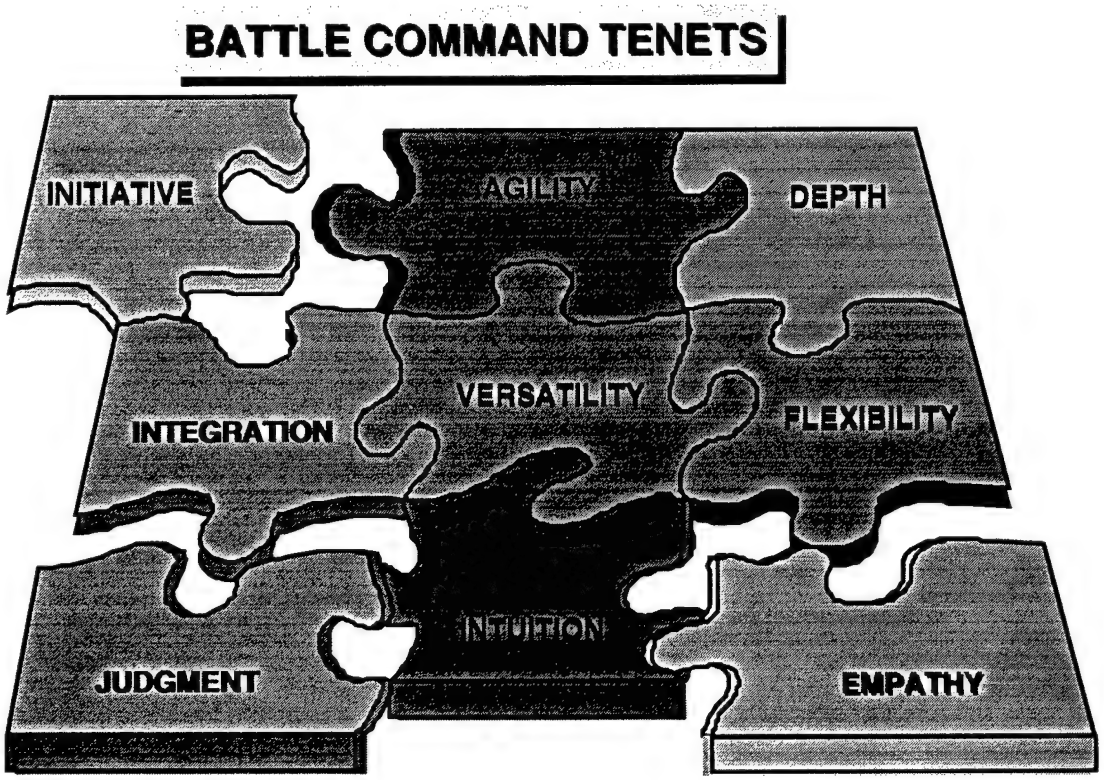
We need to go beyond simple behavioral studies which can never address the whole range of possible circumstances. We cannot simply look for direct cause-and-effect relationships between, for example, a given information format and the timeliness or quality of a commander's decisions. Instead we need to examine the underlying cognitive processes which govern the means whereby information is perceived, understood, integrated with previous knowledge, and used to reach a decision.

The battle command concept is about skilled, competent professionals faced with complex demanding tasks which must be performed to high standards under the worst of conditions. From a behavioral perspective the importance of the battle command concept is this focus on the

commander. The challenge for ARI is to address some fundamental questions about expert human behavior.

We must design, develop and apply the best means for equipping battle commanders with the most effective human "technology"; relevant human technologies include those related to the acquisition and maintenance of knowledge, skills, and abilities necessary to make decisions and provide leadership.

In what follows in this paper, we first establish some baseline principles for the development of *expertise* in general. Next we look at what we know about the specific competencies identified in the battle command concept: *viz.* decision making and leadership. We need to understand both the development and the application of these competencies. And we need to look at this information in the context of the battle commander within a larger battle command system, simultaneously empowered and constrained by the technology and people in the system. The general principles concerning the proper development of battle command skills can be used both to assess current Army practice and to identify gaps in our own knowledge which require additional research.



2. HUMAN DIMENSIONS OF BATTLE COMMAND

ASSUMPTIONS

Behavioral scientists *measure*, *describe*, *explain*, and *predict* behavior of interest. Before we can deal with any behavior in detail, we must be able to measure and describe that behavior, using a framework of concepts and theory to structure the domain. By identifying relationships between the behavior of interest and other variables, and working within the theoretical framework, we can develop explanations of cause-and-effect. Such relationships and explanations allow us to make predictions about behavior in circumstances other than those studied.

The success of an application of this scientific process to a specific domain like *decision making* or *command* may depend on: the relevance of existing theories and concepts; a new conceptual breakthrough or new approaches to measurement and analysis. Success will certainly depend on our ability to gather sufficient data on the phenomena; empirical data ultimately distinguishes the scientist from the arm-chair philosopher.

The behavioral scientist approaches a topic like *battle command* with a few fundamental assumptions about behavior in general; these assumptions shape our discussions and our research.

First, we assume that people are different, that every individual is unique. What makes people different is a blend of "natural tendencies" (inherited, genetically determined ability and/or behavior) and characteristics acquired from and shaped by experience. People are born with different potential cognitive capacities; early experiences and educational opportunities will have a major impact on the extent to which that capacity is developed. In general, our primary emphasis in the short term is on characteristics gained from experience. However, a complete understanding of factors which determine an individual's ability to be an effective battle commander must take into account the individual's fundamental cognitive abilities **and** the way those abilities are shaped during the dynamic, long-term development process.

A second pair of assumptions made by behavioral scientists is that, even though every person is unique, there is a consistency to individual behavior and there are underlying similarities among people. The first element, consistency of individual behavior, reflects the fact that individuals' characteristics and behavior tend to be quite stable over time; the shorter the time window, and the more similar

the circumstances, the more stable, and predictable, we would expect an individual's behavior to be. The second element, similarities among people, reflects the notion that, although no two individuals are likely to be *identical* in all important characteristics and behavior, there are many individuals who are quite similar in many important ways.

These assumptions allow us to identify relationships and to make predictions about future behavior. Just as the optometrist can measure how good or bad a person's eyesight is, just as the exercise physiologist can measure how strong or weak a person is, so can the psychologist develop measures of a person's aptitude for learning a particular skill or a person's acquired skill level on a particular task.

Any two persons with the same nominal eyesight may perform differently on a given task; neither the measure nor the predictive relationship to specific visual tasks is perfect. Any two persons with the "same" strength may differ in their performance on a given lifting task; again, neither the measure nor the prediction is perfect. Similarly, the psychologist may be able to identify two persons with the "same" skill level on a task, but would not expect task performance by the two individuals to be identical. We maximize the validity and utility of our conclusions by carefully developing our hypotheses and measures in the first place, and by insisting that any conclusions must be based on a reasonable sample.

A third basic assumption we make is that structured, systematic methods for observation, data collection, and data analysis will provide us with an accurate understanding of the behavior of interest. We are supported by modern statistical techniques which provide appropriate tools for hypothesis testing, describing and drawing inferences from the data we collect. Even though an individual's characteristics and behavior may be variable, and even though different persons will certainly differ in their characteristics and behavior, these within-person and between-person variations can be precisely described. We can further look at the covariation of characteristics and behavior, and draw some conclusions about the impact of the characteristics on the behavior.

The basic limitation of a statistically-based empirical approach to the study of human behavior is that our conclusions are only as good as our data. The greater the range of variation in the behavior we are studying and the greater the complexity of the task, the more data we need to be able to provide accurate descriptive statistics, much less to draw inferences based on covariation. However, the great strength of this approach is that, given the data, we can confidently generalize our conclusions and recommendations far beyond the small percentage of the population which was actually observed.

KEY DIMENSIONS OF BATTLE COMMAND

Personality variables Some individual differences can be characterized as temperaments or personality traits.. The term "personality trait" usually refers to a specific pattern of behavior that the individual manifests across situations. Examples of temperament relevant to work performance include dominance, stress tolerance, energy level, work motivation, and need for achievement. Previous research suggests some relationships between personality characteristics and combat performance. Research on military performance during the Korean War found that effective fighters were higher in stress tolerance, dominance, and were more socially mature. More recently, ratings of performance in Desert Storm were found to be significantly related to individual differences in dominance, achievement need, and emotional adjustment. Additional research in this area may yield measures that add predictive validity to the current operational Army selection and classification measures.

An integrating concept: Expertise. The general integrating concept we will use to describe battle command is that of *expertise*. Adopting this perspective on battle command has two primary benefits. First, a growing body of scientific research has addressed the complex process through which competent adults acquire the knowledge, skills, and other attributes which enable them to be proficient in their field. We have drawn on that research as a starting place to understand the characteristics and developmental processes of the battle commander. Second, the *expertise* framework helps us emphasize and maintain a performance perspective in our research. Our focus is on **expert** behavior, the effective behavior of competent individuals addressing complex tasks.

The first portion of this paper laid the groundwork by describing the battle command domain from the doctrinal perspective, the perspective of the practitioner of this "art."

Table 2:
BATTLE COMMAND TASKS

DECIDE
Formulate Concept of Operation
Visualize Terrain
Visualize Enemy
Plan Tactical Operations
Employ Assets
DIRECT
Communicate
Lead Effective Rehearsals
Control Battle
Verify Critical Actions
LEAD
Act Decisively
Motivate
Display Moral Courage
Build Cohesive Units
TRAIN
Train Proficient Unit
Mentor Subordinates
Maintain Discipline

Table 1 (page 7 above) identifies some behavioral tasks which are thought to be essential for battle command. Table 2 above provides an expanded list of tasks based on a variety of doctrinal sources. At some level of analysis, for some specific purposes, it is useful to examine each of these tasks in detail. For instance, we would expect to explore the specific processes involved in "visualizing the battlefield" in quite some detail if we were asked to provide recommendations on improving staff or commanders' effectiveness on this task. Before getting to the "eachs", however, we need to first place that behavior into context.

Many of the tasks involved in battle command are information processing tasks. In our research on battle command we will draw on the field of *cognitive psychology* which addresses information processing, problem solving, and decision making behaviors. Twenty years of extensive research on these topics provides a rich source of concepts and findings concerning both individual and group processes. One of the challenges we face is to translate and extend what we know about these cognitive processes in general to the specific domain of battle

command and to the specific problems associated with developing and maintaining the skills, knowledge, and abilities needed for effective battle command.

In the following sections we will take a more detailed look at what we know about:

>The acquisition of Expertise: (Cognitive skill development)
>Problem-solving processes
>Decision making Expertise
>Planning
>Visualization
>Situation assessment
>Metacognition
>Leadership
>Battle Command support staffs

> In modern battle, the magnitude of available information challenges leaders at all levels. Ultimately, they must assimilate thousands of bits of information to visualize the battlefield, assess the situation, and direct the military action to achieve victory. Thinking and acting are simultaneous activities for leaders in battle.
>
> *FM 100-5: Operations. June, 1993*

Developing Commanders:

Acquisition of Expertise. A key concern within battle command is the need to develop Army officers who are **effective** battle commanders, who have the *expertise* to accomplish those tasks which they are called upon to do. Expertise in any given domain involves, at a minimum:

>Knowledge
>Skills and abilities
>Attitudes
>Experience

An expert's ability to apply his or her expertise to accomplish some task in any given situation depends upon, at a minimum:

>Organizational influences
>Familiarity of circumstances
>Environmental variables

The above factors are deeply interrelated, and it is possibly misleading to highlight any one factor as **the** key element in expertise. However, there is a growing consensus that **knowledge** may in and of itself distinguish between experts and those who are less-than expert in any domain.

Knowledge acquisition. For centuries scholars and teachers have struggled with the dilemmas of how to acquire knowledge (learning, self development) and how to pass knowledge on to others (training, teaching). A common theme running through learning models as diverse as that used and taught by the Benedictines since the fifth century and that used by contemporary educators is that knowledge acquisition is a slow, iterative process, dependent in part on the active application of knowledge and on external feedback of results. The underlying cognitive process is the *organization* and *integration* of knowledge.

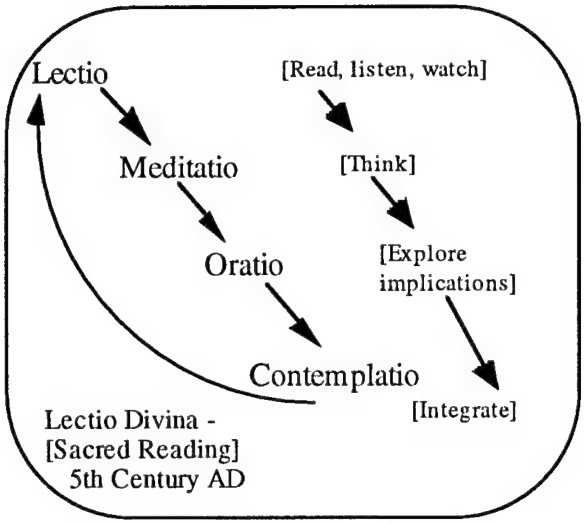


Figure 1. Fifth Century Learning Model
[With suggested parallels to modern concepts]

Knowledge Organization. Experts have a rich organization of knowledge, including many abstractions and multiple relationships. Memory elements are grouped according to underlying meanings rather than surface features. The relationships linking concepts, context, and content are more likely to be the expert's own inferences and insights rather than a framework adopted from someone else.

As an individual develops expertise in a given domain, we expect to see an increase in the domain knowledge which the individual has learned, and a change in the organization of that knowledge. Individuals first acquire basic facts and simple rules about objects in that domain. As they gain knowledge (learning) and attempt to use that knowledge (experience), they begin to grasp and refine relationships among objects and events and to go beyond simple one-to-one cause-and-effect rules. With continued development comes the organization of knowledge in more elaborate mental models.

Mental Models. The concept of "mental models" has drawn increasing researcher attention over the last twenty years. One strong impetus was the interest in developing knowledge-based Artificial Intelligence systems. Researchers trying to represent human problem solving found that knowledge organization had a major impact on problem solutions. A separate research community was giving renewed attention to the process whereby adults learn and develop. In this diverse research literature we find a variety of labels and descriptions for mental models; we also find a growing consensus that *the formulation of elaborate mental models is a key step in the development of expertise.*

> Perception of objects and events...form a natural beginning for mental models that people develop and use to adapt to their environments....A mental model has both descriptive and explanatory functions. It bears on the questions, *what-how-why*. The *what* is descriptive, referring to the structural aspects, together with some representation of the action of the model. The *how* may include both descriptive and explanatory functions, the former referring to static structure or to temporal evolution, the latter to causal interaction. The *why* is explanatory, and could perhaps be subsumed within *how*. *Why* allows representation of purposive concepts,...
>
> *Anderson & Wilkening Adaptive Thinking in Intuitive Physics*

Mental models are understood to be dynamic structures that group knowledge based on perceived similarity and meaningful regularity. The models provide the framework for storing patterns of factual knowledge, including knowledge of associated procedures and results. An intelligence officer, for example, could be expected to develop one or more reconnaissance-and-surveillance mental models or "schemata" which provide the organizing framework for managing the large amounts of detail concerning capability and suitability of a vast array of intelligence collection assets. The use of drills in crew and unit training and the use of "playbooks" in tactical planning both

represent instances where the Army has implicitly recognized the concept of "schemata" as aids to understanding, and has provided explicit schemata to facilitate communication and comprehension of complex actions.

As individuals experience, learn, and grow in their grasp of a knowledge domain, they may reach the stage of developing and using very rich, complex mental models to organize, store, and use large amounts of knowledge and information. With use, knowledge may become highly proceduralized. Whereas a novice must go through a deliberative process to assess a problem situation and identify a particular response, an expert is likely to have already done the deliberative thinking. The expert has stored the "patterns" of elements from a variety of situations and either has a ready-made response for those situations or can construct a new solution from elements of previous ones.

It is important to note that while experience is an important element in the growth of expertise, experience alone is not sufficient. Reflection and introspection are also essential to the development of expertise. Synthesis and integration are essential underlying processes. Individuals without the skills or capacity to reflect, to understand, to integrate and synthesize new experience and knowledge with previously held knowledge cannot increase their level of expertise. The emerging expert, on the other hand, does grow, develop, and acquire rich mental models which serve to shape and organize his or her perception of the world.

The organization of knowledge provided by mental models helps keep the individual from being overwhelmed by information, allowing him or her to deal with patterns of data within a known framework. The richness of the expert's mental models allows the expert to deal with multiple interpretations and conflicting data; in general, an expert is more adaptive to new circumstances than the less expert individual.

The mental models an individual develops are important in determining whether or not the underlying knowledge can be put to effective use; however, the underlying knowledge content is equally critical. A military historian with a rich mental model based on the principles of war and populated with extensive knowledge of Civil War engagements would probably be an ineffective battle commander if he or she did not also have integrated knowledge of modern combat systems and doctrine. As discussed later in this paper, relevant knowledge includes both "tacit" and explicit knowledge, both general and specific knowledge. Relevant knowledge includes knowledge about objects, but also knowledge about complex relationships among objects.

One of the implications of this perspective on battle command expertise is that we need to develop a better understanding of the proper mix of training, education, self development, and other experience for developing expert battle commanders. Furthermore, the issue goes beyond asking what the battle commander needs to know; we need to understand how that knowledge could best be organized.

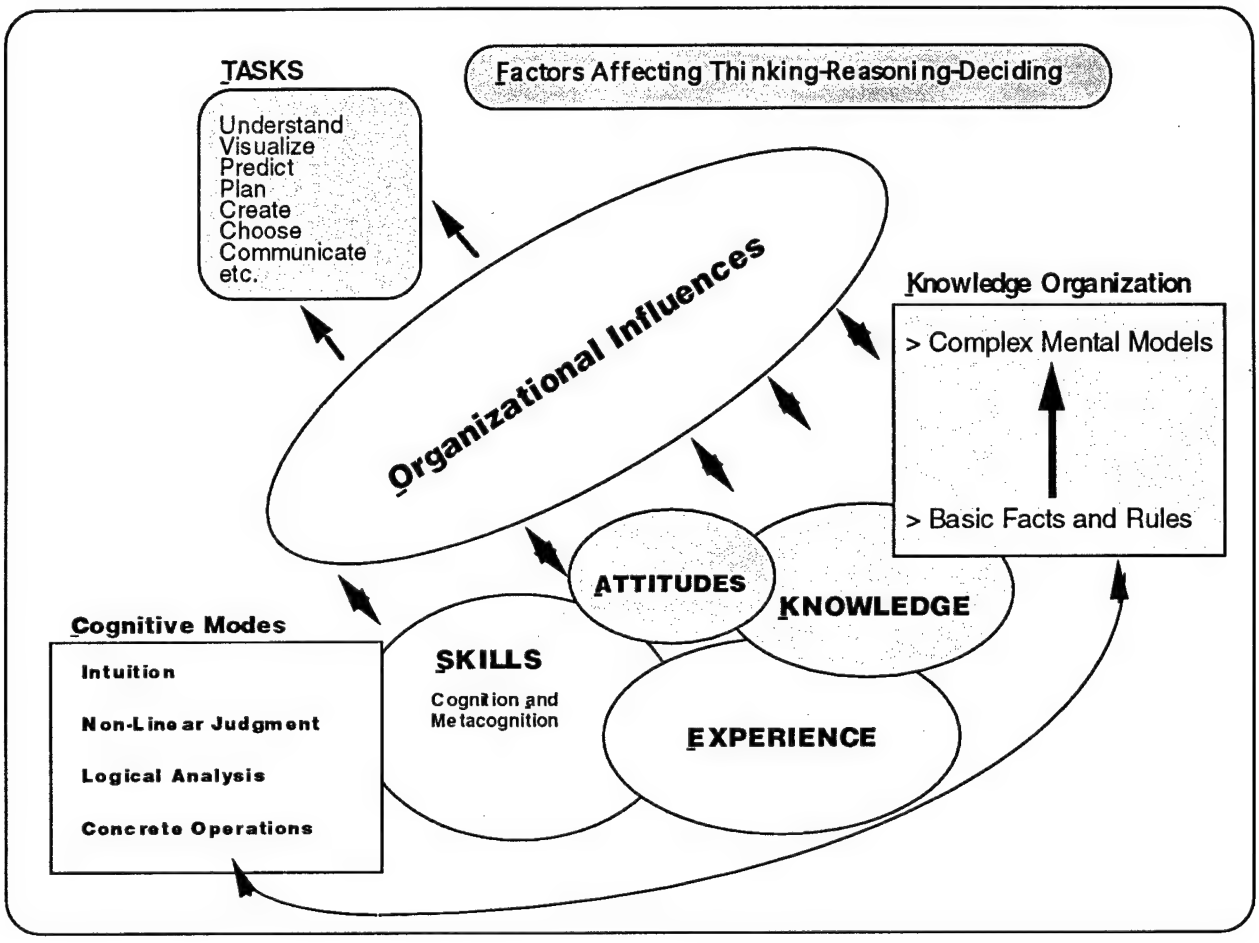


Figure 2. General Model of Battle Command Expertise

Thinking skills. To this point we have argued that a key characteristic of experts in any domain is that they have a richer knowledge base, and have effectively organized and integrated that knowledge. Given necessary knowledge to address problems and make decisions within a domain, an individual also requires a number of thinking skills; an important aspect of expertise is the possession of **metacognitive** skills, the ability to consciously monitor one's own thinking process, to choose among alternative problem solving approaches, or to adapt existing approaches to unusual problems. Given the necessary thinking skills, and particularly given metacognitive skills, an individual can operate in any of several **cognitive modes**, to include intuition and logical analysis.

It is important to note that experts are not necessarily more intuitive, they are just better problem solvers and decision makers. As discussed above, in some domains an expert's knowledge may be so well organized and practiced that it becomes "proceduralized." Recognition of a problem brings to mind a solution to the problem without conscious thought. The result of an expert's intuition may be quite different from one who is not an expert. The non-expert probably sees a much simpler problem. For example, an expert battle commander may immediately interpret intelligence data that indicates a major enemy counter-offensive, and may "intuitively" choose to commit reserves against the main thrust of the attack. The non-expert may well be incapable of thinking about the larger tactical implications and might see the same information as

indicating nothing more than a localized engagement. Both the expert and the non-expert may be right or wrong in their intuitive judgments and decisions, but we would expect the expert, with a deeper, richer, more complex knowledge base, to be right more often. Metacognitive self-monitoring skills play an important role as individuals decide whether to "go with" their intuition or to wait and think the situation through in more detail.

Summary. We have sketched the general factors which impact on an individual's level of expertise in a domain like battle command, looking particularly at the development of mental models. As shown in Figure 2, there are a variety of factors other than knowledge and knowledge organization which influence the extent to which a knowledgeable expert will achieve success on a given task. General implications of these relationships are outlined below; some of these points are developed in more detail later in this report.

>Experience is a critical component in acquiring knowledge **and** in helping to integrate that knowledge within developing mental models.

>The best experience for developing expertise is not always that which most closely resembles the target tasks. For example, the challenge of explaining and teaching the principles of war to ROTC cadets may provide opportunities for officers to develop their own understanding; this may be an important supplement or replacement for the experience of participating in a series of mock battles.

>Knowledge alone is not enough; an individual needs certain thinking and reasoning skills.

>Like other skills, we would expect that thinking and reasoning skills could be taught and practiced; however, there is much we do not yet know about the intentional development of thinking skills.

>Individuals with the proper "metacognitive" skills can consciously adopt the most appropriate mode of operation under particular circumstances (i.e., reliance on intuition *vs.* logical analysis as a function of time available); the truly expert may make such metacognitive judgments intuitively.

>Even given a high level of knowledge and skills , an individual still may not be an effective performer without the will and desire to succeed. Patriotic beliefs, for example, seem to be formed by early experience, but other necessary attitudes, such as the drive to succeed, are acquired or shaped, at least in part, through observation of proper role models, through effective mentoring, and through self-discipline.

>Any individual, even a senior commander, works within a larger organizational structure. The battle commander's performance will be mediated by a variety of organizational influences. The ability to shape organizations and to indirectly influence events, are important elements of battle command expertise.

>The knowledge and skills required of a battle commander go beyond thinking skills and tactical and technical knowledge. The effective battle commander also must acquire knowledge and skills related to "interpersonal" tasks which include leadership and managing an organization.

Problem Solving and Decision Making An ongoing ARI in-house research project is exploring the many types of problem solving and decision making strategies which have been identified in the literature; 66 distinct strategies have been documented to date. The compilation will provide the starting point for: (a) new methods to trace the judgment and decision processes of battle commanders; (b) identifying and understanding effective decision strategies; (c) comparing battle command to other decision domains; and (d) developing decision aids and instructional materials to improve battle command.

Although this is work in progress, we can draw several preliminary conclusions based on the review to date.

>Everyone uses a variety of strategies for problem solving and decision making; more successful decision makers may have a larger repertoire of strategies to draw on.

>The explicit use of metacognitive processes to control the selection of strategies may significantly increase the likelihood of successful problem solving.

>Selection of the appropriate problem solving strategies for a given task seems to increase the efficient use of mental resources, lead to higher quality decisions, and reduce the likelihood of costly errors when solving problems.

>To effectively use strategies one must have appropriate domain knowledge **and** one must know when, how and why to apply that knowledge.

>A major factor in selecting the strategy or strategies to apply to a given problem is the, often implicit, tradeoff among effort, accuracy/precision, and time.

>Training future battle commanders to be proficient problem solvers would give them more flexibility and thereby greater adaptability to changing circumstances and novel problems.

>A problem solver is often faced with the task of making high quality decisions in complex, variable, ill-defined, novel situations; effective problem solvers will be able to choose from a variety of strategies and/or use their experience and domain knowledge to adapt or piece together old strategies.

>Any training of cognitive strategies should be linked to increasing domain knowledge from relevant problem areas rather than focusing only on the process or procedure.

Decision Making Expertise[1] Above we discussed the general concept of **expertise** in the context of theories of adult development. Within this perspective, the emphasis is on knowledge and knowledge organization. A recently completed project examined the application of expertise to tactical decision problems. The subject population included a total of 46 Army officers, ranging from Captain to General, with the majority (32) of participants at the rank of Major.

Participants were individually asked to talk their way through two of four different tactical situations involving a division-sized force. Role-playing as the division commander, they were asked to explore the available information and to provide the commander's concept of operation and planning guidance for their staff. The process they followed in developing their product was evaluated by a team of behavioral scientists. The process used by the participants and the products generated were also evaluated by three retired general officers (Lieutenant General or General). These three individuals all have extensive experience in observing and evaluating tactical decision making in large-scale training exercises.

The hypotheses investigated in this project were based on a five-step model of the application of expertise in tactical planning and decision making. We assumed that experts would be able to quickly generate a concept and initial plan based on prior experience with similar situations. Given the initial plan, they would then ask the "right" questions to get more information; this would lead them to a fuller, integrated picture of the situation. They would use their tactical and technical knowledge to visualize alternative possible outcomes and, finally, would develop a robust and flexible concept of operation.

[1]A recently completed two-year project conducted by ALPHATECH , Inc. for ARI developed a comprehensive model of expertise in tactical planning. This section summarizes the conclusions and recommendations from their report.

High-Expertise Group	Low-Expertise Group
(+) Focus on Mission	(-) Lost mission focus
(+) Dynamic visual-ization of the battle-field	(-) Unable to read battlefield
(+) Mastery of time-space dynamics	(-) Intent and orders lack detail and clarity
(+) Good coordination of fires and maneuver	(-) Key details missing: fires, maneuver, deep battle
(+) Able to mass combat power	(-) Unable to put METT-T theory into practice
(+) Clear understan-ding of relationships with Corps	(-) Did not use corps resources
(-) Need better logistics and fires concepts	(-) Did not under-stand use of boundaries
(-) Need better setting of priorities	(-) Fighting another unit's battle

Table 3: Key qualities (+) and shortcomings (-) of participants.

The data gathered by behavioral observation supported many of the hypotheses, and the general process described above was validated as an adequate overall description of the application of expertise. Perhaps most surprising was that the participants in the study made little explicit use of prior experience or historical examples in their analysis of the situation.

The data gathered from our panel of retired general officers correlated highly with our behavioral data. Those participants who did the things that we thought "experts" would do are the same participants who were highly rated by the judges both on their product and on the process they followed. Table 3 presents the judges' summary of the key qualities and shortcomings of those they judged to be most expert, and the key shortcomings of those they thought were having the most difficulty in addressing the problem. The judged expertise was not strictly associated with rank or years of experience. The high-expertise group included 1 general officer, 2 colonels, and five majors, while the low-expertise group included 1 colonel, 6 majors, and 1 captain.

Despite the generally positive results and the strong potential for use of the methodology and results to support development of battle commanders, there were surprises which indicate the need for additional research in this area. In particular, it is clear that expertise is not a simple matter of intuitive pattern-matching. Participants in this study and in other research exhibit a wide range of cognitive skills and modes of operation; future research will need to explore in greater detail the cognitive dynamics of situation assessment and decision making.

Planning[2] The critical importance of the battle commander as a leader and motivator during the execution phase of a battle cannot be overemphasized. However, as unit leaders and decision makers, battle commanders must have a plan for their units to follow. Whether planning is done with the luxury of a large staff, in comfortable surroundings, and with ample time, or is done on the spot by commanders forward with their units in the heat of battle, the plan is critical to the successful accomplishment of the units' mission. Planning is the process whereby means to reach/accomplish/satisfy a goal are determined. Without a coherent plan, a commander has little basis for either command or control.

Tactical planning has been a focal point of ARI research for several years. Numerous analyses verify the critical role of this function; however, our early observations in the area made it clear that there was a large mismatch between planning as taught in Army schools and planning as performed during training exercises or operations. The following points include both specific conclusions about the status of tactical planning in the Army and general observations on the planning process .

[2] This section is based in part on ARI Technical Report, Number 984, **Overview of Army Tactical Planning Performance Research**, September, 1993, and in part on material presented to CAS3 curriculum developers in December, 1993, both by Dr. Jon Fallesen.

Observations on tactical planning.

>Tactical planning procedures are integral to Army doctrine. However, at any given time, there are inconsistencies among doctrinal and training publications as to what those procedures are or should be.

>Estimate procedures are not closely followed in Army tactical exercises. The primary cause seems to be a mismatch between the doctrinal procedures and what is possible under time-constrained conditions.

> The estimate process worked well during planning, but the speed of the offensive operations forced me to analyze the situation with little input from staff members and make a decision. The key factors were friendly unit locations, known enemy locations, fuel status, ammo status, and the spot where my commander wanted me to go or I decided to go. I ignored or overcame all else.
>
> *Battalion Commander, comments on Desert Storm Experience, reported in Halpin and Keene, 1993*

>Those managing the planning process at division-level exercises often fail to consider all necessary functional areas, often do not sufficiently involve the commander, and often lack control of the planning procedures. Time management is a continuing major problem.

>Coordination within and between staff sections and command posts is weak; very little relevant information is shared among staff sections. When information is shared or is briefed to senior officers, there is often little effort made to discuss the relevance or impact of the information.

>Tactical situation assessments often fail to: (a) consider battlefield factors; (b) consider enemy intentions or capabilities; (c) verify assumptions; (d) assess information quality; (e) interpret information; or (f) make predictions.

>Little attention is paid to formulating honest alternatives to proposed tactical courses of action. Good alternatives which are considered but rejected are typically not recorded for possible later use as contingency plans.

>Division-level plans in major training exercises frequently fail (60%) due to incomplete planning, insufficient combat power, and poor synchronization.

Recommendations for improved planning.

>Plans should be developed using procedures determined during the planning process, rather than following rigid *a priori* stepwise procedures. Metacognitive skills of scheduling, allocating, and prioritizing play an important role here.

>Planning should occur at different levels of abstraction, neither purely top-down or bottom-up but multi-directional.

>Plans are intended to achieve certain goals and objectives within known constraints of time and other resources. Improved planning may result from a careful, explicit, identification of goals, and from the use of constraint-based problem-solving strategies.

>Plans are typically created from parts of previous plans (existing knowledge). Previous plans need to be remembered, combined to fit the demands of the situation, tested, and conflicts resolved or trade-offs made.

>Better planning can be realized by developing the repertoire of partial plans (emphasizing conditions under which they apply and those where they don't), learning to use analogical reasoning to develop plans for unfamiliar cases, planning for contingencies, and using mental simulation, visualization, and prediction.

>Doctrinal and training materials should de-emphasize the deductive, decision-analytic approach to tactical planning, particularly with respect to the estimate process. We focus much of our officer training on staff officers, yet we

try to teach them to be decision makers. Staff officer training should focus more on effective planning. Particular examples of doctrinal guidance which seem counter-productive to good planning are "avoid making early decisions" and "avoid comparing courses of action during wargaming".

>Additional research is required to establish the efficacy of instruction designed to modify and enhance individuals' planning strategies.

>The shortcomings we have observed in tactical planning are not just due to confusing or inadequate doctrine, techniques and procedures. Most officers have not been provided formal instruction or training on the basic thinking skills needed to accomplish tactical planning. The following candidate list of skills is proposed as the starting point for a fresh look at the instruction we provide Army officers. We need to help develop skills related to:

- Situation assessment (what is);
- Exploration (what is possible);
- Flexibility in representation and communication of situations, goals, and options;
- Deconfliction of what the situation is, what means are at hand to accomplish the goals, and what the goals are;
- Analogical reasoning;
- Mental simulation and visualization;
- Prediction and anticipation;
- Critiquing to check for consistency of assumptions;
- Metacognition.

Visualization[3] The cognitive process referred to as visualization is given prominence in FM 100-5 and other writings on battle command, reflecting the conviction of experienced commanders that the ability to see and understand current and future battlefield dynamics is an essential component of battle command. However, the implied processes are poorly understood by cognitive scientists. For example, it is not clear whether the phenomenon reflects a skill that anyone can develop with practice or is based on an innate ability.

Two recent ARI projects have begun the exploration of "visualization." Preliminary findings and observations are listed below.

Hypotheses derived from cognitive theories. Ainslie et. al. address visualization from a behavioral science perspective and from the standpoint of available and future battlefield technologies. They emphasize the following points.

>Visualization of the battlefield is an active cognitive process which goes well beyond simple pattern recognition.

>An officer's fundamental knowledge of tactics, techniques, procedures, and battlefield dynamics provide an important basis for visualization.

>Some form of mental simulation, or wargaming, may be critical to successful visualization. However, research has shown that mental simulation is rarely used, and then often used poorly. Effective use of this problem-solving technique may require a high level of domain expertise.

Research findings. Solick et. al. describe an ARI in-house experiment designed to assess visualization skills of task-force commanders and their staffs. Sixty-two officers participated in the research, including eight battalion commanders and a variety of intelligence and operations officers. Participants individually

[3]Based on Draft **Final Technical Report**, Francis M. Ainslie et. al., March 1994, and Draft ARI Technical Report **Visualization and Judgmental Forecasting of Simulated Battles**, Robert Solick et. al., March 1994.

proceeded through two scenarios based on data from actual engagements at the National Training Center (NTC). At selected points in the unfolding scenario they were asked to visualize current unit location and status; at other points they were asked to forecast future locations and strengths. Their judgments and observations addressed both US and Opposing Force units. The following findings are based on examining the accuracy and completeness of their judgments.

>Being able to listen to the unfolding battle on tape recordings captured from a command radio net was critical for accurate visualization. In a pilot study using only a series of graphic "snapshots" to describe the scenario, it was found that the visualization task was almost impossible.

>On average, older, more experienced officers were slightly better than younger officers on several visualization tasks but some of the best individual results came from captains and the one lieutenant in our sample.

>More experienced officers tended to make more accurate location forecasts; however, they were less accurate in making unit strength forecasts.

>More experienced officers were better able to deal with a scenario which followed a typical progression for an NTC engagement. Less experienced officers were better able to deal with a less predictable scenario.

>Only one cognitive test, Building Memory, provided a strong prediction of officers' performance on the visualization tasks in this experiment.

Situation assessment[4] The ability to quickly "size up" a situation is clearly a desirable skill for battle commanders, as is the ability to know or find the essence of a situation. An ongoing ARI project is exploring the cognitive elements involved in tactical situation assessment; a preliminary extract of key points is listed below.

>Speed and accuracy in understanding come from extensive experience combined with reflection on that experience. It is important to realize the significance of a situation, its generality and its uniqueness; otherwise little or no learning will take place.

>Many decisions (assessments) are based on recognition: given the recognition of a certain situation, an appropriate response is already known.

>"Understanding" a situation is similar to the development of plausible stories (explanation-based), whereby situation-specific evidence is combined with general knowledge and similar cases. (Inference plays a role here.)

>Possible subskills which may be used to explore and search for underlying meanings, include:

- Classification
- Comparison, relating similarities
- Abstracting/generalizing
- Elaboration (building hypothetical patterns and testing against the environment for goodness of fit)
- Critiquing (challenging/testing facts, assumptions)
- Deconfliction (of unlikely paired events and/or situations)

>For novel, ill-structured problems, the individual must be willing to explore the situation to test what something might be. If a known pattern does not come to mind, then an expert will spend more time than a novice in structuring the information into something meaningful. A willingness to develop nontraditional representations, to find unique elements of a situation is important to an expert battle commander. Ambiguities are tolerated and uncertainties are purposely resolved.

>A unique aspect of battle command problems is dealing with an intelligent adversary who's short-term intentions are uncertain. Knowledge about possible intentions is weighed and evaluated and is considered in relation to

[4]Extracted from **A Cognitive Framework of Battlefield Commanders' Situation Assessment**, October 1993 Draft Report from Cognitive Technologies, Inc.

the goals that a commander is trying to achieve with the entire force.

>We need to further develop our model of battle command situation assessment: how are the complexities of the battlefield interpreted? What means of determining truth or likelihood are used? What is the role of analogical, inductive, and other thinking skills?

Metacognition[5] We have made several comments about "metacognitive" skills and their importance for higher quality decision making. Metacognition is the awareness by individuals of their own cognitive processes, in relation to cognitive demands of problem solving situations. Metacognitive skills are the higher order executive processes which individuals use to plan, monitor, and evaluate their own problem solving.. This section provides more discussion of these particular cognitive skills.

METACOGNITIVE SKILLS
> Determining what the problem is.
> Selecting lower-order components to solve the problem.
> Selecting information representations.
> Selecting strategies for combining lower-order components.
> Deciding how to allocate attention.
> Monitoring the situation: what has been done, what is being done; what still needs to be done?
> Monitoring feedback, altering behavior on the basis of feedback: How am I doing?

Table 4. Metacognitive skills.

Critical battle command problems generally will be complex and ill-defined. They may also lack structure, in the sense that the addition of available information may fail to produce obvious, definitive solutions. Situations may suggest more than one problem solution strategy, and mutually exclusive solution strategies of equal value may coexist. One type of metacognitive skill required in this context is the ability to recognize, first, that there is a problem, and second, what the form of the problem is. For example, not all problems can be addressed within a reasonable time by straightforward analytic methods. Application of his or her metacognitive skills of problem recognition and representation help the expert problem solver choose the right problem solving tool(s).

Once the form of the problem is identified, a second aspect of metacognition is the explicit selection of the problem solving approach(s) to use; this includes deciding how to represent and select the relevant information. Problem solvers establish criteria for identifying a limited number of viable categories applicable to the situation at hand. This implies a previous process of organizing knowledge via mental models as discussed earlier. Mental model formation includes establishing principles or rules for relating information categories to situations, probably through the mediation of a higher order representation.

Attention allocation is a particularly critical metacognitive skill. Commanders who are less than expert but who face no unanticipated problems and little time pressure will be able to follow established procedures and checklists to successfully solve a series of problems. Commanders facing more complex or unanticipated problems under significant time pressure must have the ability to allocate their attention to the critical issues. An expert commander knows when to carefully follow procedures, when to quickly follow procedures, and when to ignore the usual way of doing things.

Another critical type of metacognitive skill relates to monitoring and assessment. Expert battle commanders are more likely to be consciously aware of both the situation and their own approach to dealing with the situation. They are likely to maintain a running assessment of progress toward reaching the goal.

[5] This discussion is drawn from several sources; the key concepts are derived from Robert Sternberg's triarchic theory of intelligence.

The concept of "metacognition" provides us a perspective on the cognitive processes of domain experts which may help to explain some of the differences in competence among battle commanders with apparently similar knowledge and experience. The thinking and problem solving skills discussed earlier and the "executive" metacognitive skills described here represent the tools necessary to use the knowledge available. Some research findings indicate that it may be possible to train and practice these skills; however, the available research does not support specific recommendations for integration of metacognitive skill training into the officer development process.

Senior Leadership Most of the discussion of battle command to this point in this report has focused on the decision-making aspect of command. This section discusses the leadership aspects; as will be seen, our perspective on the requirements for leadership, particularly senior leadership, is fundamentally the same as our perspective on tactical decision making.

Leadership is the process of identifying objectives and goals which must be achieved by the responsible organization, and obtaining the positive commitment of members of the organization to achieve them. Future war (and operations other than war) will require enhanced leader thinking skills at all levels, together with the capacity to operate independently. The work of Senior and Strategic leaders (brigade and higher), is extraordinarily complex, and the problems they deal with are often ill-defined and unstructured.

Effective leadership at these levels requires a "mental map" (frame of reference) for problem finding, solution generation, and implementation. The frame of reference must include systems understanding, recognition and capacity to use second- and third- order effects to attain objectives, and a time horizon that allows envisioning long-term objectives and needs of the organization.

All leaders must "add value." Each successively higher echelon must deal with successively more complex issues, and provide an overarching framework that gives meaning to the actions of more subordinate echelons.

Major areas of senior responsibility include: managing joint and lateral relationships; representing the organization; managing the flow of information necessary for coordination of the activities of the organization with the activities of higher echelons; maintaining the readiness of the organization through monitoring and resource allocation; monitoring the organization to maintain the integrity and integration of its operating systems, to include the well-being and commitment of the soldiers and families who constitute the organization.

Skills that differentiate Senior and Strategic leaders include:

>Cognitive skills
- Mental mapping (shared frames of reference; systems understanding; understanding of joint and combined relationships; and development of an external perspective).
- Problem solving/management.
- Planning/Envisioning

>Skills involved in dealing with uncertainty and risk taking.

>Communication/Interpersonal skills
- Networking
- Consensus Building
- Getting Feedback
- Use of communications technology

>Resources Management
- Personnel
- Materiel

Senior and Strategic leaders must instill appropriate values within their commands. They must be concerned with building and maintaining a positive command climate, essential for human resources development and for the creative, independent action of subordinate leaders in situations in which they must operate alone. Excessive control and the inappropriate use of punitive measures limit the growth of subordinate leaders' capacity to deal with complex unstructured problems. The senior commander must set the example in building command values respecting the individual dignity and worth of the soldiers within the command.

Senior commanders must ensure that the subsystems of the organization are integrated toward maintaining readiness, and effective mission execution. The subsystems include planning, information, and control. Considerations include climate, time horizon, opportunity costs, and perspective taking (seeing from the perspective of others, to include the enemy).

Battlefield leadership incorporates more than rehearsals, commanders intent, briefbacks, position on the battlefield, and communication. Successful leadership demands proper use of key personnel....Techniques we found in common, across operation and across unit, were heavy reliance on battle captains, command posts staffed with like-thinking people, liaison officers, ...

It is imperative, for successful combat operations, that the personnel within the command post be similarly trained, have a common understanding of the operation and the commanders intent, and understand the expectations of the commander. ...Commanders stressed that staffs must speak the same tactical language and understand the rapid orders process. They must understand their role in mission accomplishment and what the commander expects from them.

TRADOC PAM 525-100-1 Leadership and Command on the Battlefield: Operations JUST CAUSE and DESERT STORM, October, 1992

Senior commanders must focus strongly on human resources development within their commands -- ensuring that soldiers can be all they can be -- and must foster this philosophy within the command, recognizing that it will continually be eroded by less thoughtful leaders and commanders who are more comfortable with mechanical control. In this regard, Strategic leaders must also be concerned with the Army's role in the larger society as a net contributor to the nation. Senior and Strategic leaders must similarly be concerned with leader development at all levels.

Perhaps most important, Senior and Strategic leaders must produce organizations with the following characteristics:

>Clearly defined purposes, missions, goals, and objectives that are consistent with society's culture and values, and in support of national objectives.

>Congruence between the organizational culture, values, and policies as stated at the top levels, and what is thought at the operating level.

>Organizational structures that are consistent with purposes and missions.

>An efficient process structure: information, planning, and control.

>A human resources system that produces soldiers who are professionally and technically qualified, who are satisfied with their job, and who are dedicated to the organization's mission, purpose, and values.

>Leaders who are technically and tactically proficient, skilled in communications, strongly motivated, conceptually sound, energetic, and dedicated to the principles of the Constitution.

Tacit Knowledge for Military Leadership[6]

Robert Sternberg and his colleagues at Yale University have studied human abilities in real-world settings. A principle distinction they make is between academic and practical intelligence. Academic intelligence refers to the abilities typically valued in schools. These abilities include reading or listening to formal, explicit instruction on the content and rules of a given discipline; this sort of intelligence is measured by conventional abilities tests. In contrast, practical intelligence refers to abilities which involve observing, imitating, and applying the informal, unspoken strategies that lead to success in real-world pursuits. Practical intelligence is the ability to learn about, rather than of, a discipline, and it is poorly measured by conventional abilities tests.

Sternberg and his colleagues have taken a knowledge-based approach to understanding practical intelligence. A major finding of their research has been that much of the knowledge necessary for success in real-world pursuits is tacit knowledge.

Tacit knowledge has three characteristic features. First, it is procedural in structure. It takes the form of "knowing how" rather than "knowing that." Second, it is instrumental to the attainment of goals which people value. Third, it is acquired with little help from others. Knowledge with these properties is called "tacit" because it often cannot be articulated by the person, but must be inferred from their actions or statements. Tacit knowledge is knowledge that is unspoken, under emphasized, or poorly conveyed relative to its importance for practical success.

Tacit knowledge is not a proxy for general intelligence. Neither is it a proxy for personality or cognitive style. Although these resources may support the acquisition and use of tacit knowledge in important ways, tacit knowledge is not reducible to any one of them. Research by Sternberg and others shows that the predictive value of tacit knowledge with respect to job performance is not due to general intelligence, personality, or style.

Successful performance usually requires general intelligence in (at least) the normative range, motivation to succeed, non-tacit domain knowledge, and many other resources. Our approach does not deny the importance of these factors, but rather attempts to supplement them and improve performance in real-world settings.

What Tacit Knowledge is For. According to the underlying theory, intelligence is defined by Sternberg as the "purposive adaptation to, selection of, and shaping of real world environments relevant to one's life and abilities". Tacit knowledge is an important part of practically-intelligent behavior because it helps people adapt to, select and shape one's external environment. Tacit knowledge can play an important role in modifying one's behavior to meet the requirements of that environment.

In previous research a tacit-knowledge approach has been successful in identifying practical intelligence and performance in diverse domains. Tacit knowledge has repeatedly been found to increase with experience in a domain. For example one study found that scores on a tacit-knowledge test increased with experience of salespeople. Similar results have been reported in studies of bank managers and academic psychologists .

Tacit-knowledge scores have been found to predict job performance according to a variety of criterion measures. For example, in a study of managers of high-technology manufacturing companies, tacit-knowledge test scores correlated significantly with compensation (.39), compensation corrected for age (.38), and

[6]This summary is extracted from an ARI report in press: Horvath, J.A., Williams, W. M., Forsythe, G. B., Sweeney, P. J., Sternberg, R. J., McNally, J. A., & Wattendorf, J. **Tacit knowledge for military leadership: A review of the literature.**

subject's level within the organization's reporting structure (.36). .

Preliminary findings of a research project focused on military leaders are that the tacit knowledge held by military leaders places less emphasis (compared to tacit knowledge for civilian managers) on self- management, learning from others, and envisioning the future. Military leadership tacit knowledge appears to supplement and guide the application of leadership knowledge contained in Army doctrine. With the exception of tacit knowledge for solving organizational problems, the tacit knowledge for military leadership appears to apply across organizational levels. Subsequent research is expected to elaborate on these findings.

THE STRUCTURE OF TACIT KNOWLEDGE
INTRAPERSONAL TACIT KNOWLEDGE
=>Managing the self
=>Seeking challenges and control
INTERPERSONAL TACIT KNOWLEDGE
=>Influencing and controlling others
=>Supporting and cooperating with others
=>Learning from others
ORGANIZATIONAL TACIT KNOWLEDGE
=>Solving organizational problems

Table 5 The Structure of Tacit Knowledge for Military Leadership

Battle Command Support Staffs

It is important to emphasize the battle commander **in context**. The model of the command decision cycle shown below (p. 30) was developed by ARI over the last several years to reflect our observations of commanders and their staffs during 20 CPXs, many of them conducted by the Battle Command Training Program (BCTP). We found the FM101-5 and similar models of C2 and the command decision process to be unsatisfactory because they showed a **linear** process, with a smooth progression from receipt of a mission through development and selection of options to issuance of an order. In our observations we never saw such a process at work Rather, we saw the commander involved at all stages, with variations from individual to individual and from situation to situation in terms of the commanders' emphasis on different stages of the process. We developed the Army Command and Control System (ACCES) model to better represent battle commanders' roles within the context of their staff and subordinate commanders.

Evaluation of staff effectiveness. Data were gathered in 10 recent exercises using the ACCES model and procedures . The following general conclusions are based on that data.

>The typical division order was superseded by a change-order in less than 11 hours. The typical duration for major elements of division orders was:

- Missions - 24 hours
- Task organization - 13 hours
- Schedules - 16 hours
- Boundaries - 22 hours

>More than half of the divisions' plans were unsuccessful (could not be executed without complete revision).

>Situation assessments and analyses of alternative courses of action looked out less than 20 hours into the future.

>Discussions of Enemy Situation included Enemy Courses of Action only 54% of the time and included Enemy Combat Power only 62% of the time.

>Forecasts of Enemy Activity looked out about 14 hours into the future, on the average.

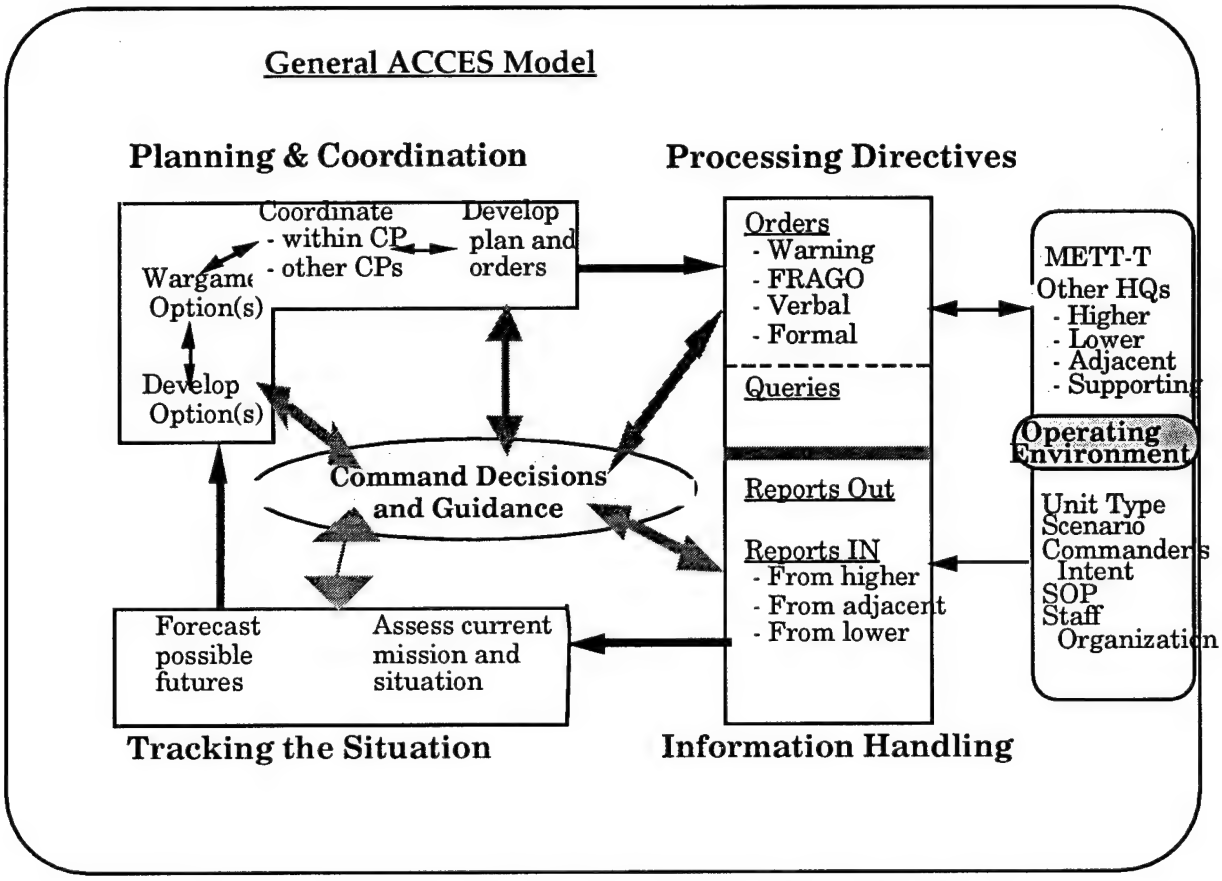


Figure 3. The Army Command and Control Evaluation System (ACCES) model of the command decision cycle.

The ACCES procedure focuses on the staff process. Until the 1994 Prairie Warrior Exercise at Fort Leavenworth we had not attempted to closely track the unit commander decision style, interactions with the staff, etc. Our data, as outlined above, speak to the effectiveness of the staff process but do not directly address the battle commander.

Going beyond the ACCES data, our subjective assessment of the commanders in these exercises is somewhat more positive. Commanders seldom were seen to make fundamentally bad decisions, given what information they had to work with. Most commanders in the units observed showed a broader and deeper understanding of the tactical situation than their staff, even though the commanders were operating with less detailed information. However, to the extent that their information was based on staff-officer assessments which had a limited vision of the unfolding battle, then the scope of the commanders own vision was limited.

> Training and teamwork during peacetime builds staffs and subordinate commanders who can anticipate requirements, and who have the mental agility to react to the fluid nature of the modern battlefield.
>
> *TRADOC PAM 525-100-1 Leadership and Command on the Battlefield: Operations JUST CAUSE and DESERT STORM, October, 1992*

As we discussed briefly above, the rapidly developing information technologies, have the potential for providing battle commanders with massive amounts of data and information about their own forces and the enemy. That information will be accurate and timely. It may

also be too voluminous and detailed for any one person to scan, much less absorb, understand, and act upon. Specialists in various intelligence disciplines, for example, may still be needed to interpret, aggregate, and draw meaning from intelligence data. Providing commanders more direct access to better information, given their greater experience and expertise, will allow commanders to build a richer mental map of the situation; information and recommendations from staff officers can then be interpreted within that broader understanding. However, the staff will retain a critical role in providing the commander processed information required for command as well as control.

Development of staff officers. The importance of the battle commander's staff goes beyond their role in support to the commander. Members of that staff, in all likelihood, are the Army's future battle commanders. In 1990, ARI's Infantry Forces Training Research Unit at Fort Benning began research on staff training for battalions and task forces; this echelon represents the least complex system where the effectiveness of staff integration and functional synchronization could be examined. A detailed examination was conducted of the tasks and roles of staff officers in tactical units and of the preparation those officers received. The following is a brief discussion of those findings.

Maneuver Branch Programs of Instruction (POIs). The objectives and course contents of current resident maneuver branch officer basic and advanced courses were examined to determine the time dedicated to training lieutenants and captains for battalion staff duties.

Officer basic courses. The primary objectives of both the Infantry and Armor Officer Basic Courses (OBCs) are to qualify Second Lieutenants with respective branch technical and administrative skills and to train them to lead and fight their platoons. OBC students receive administration, intelligence, operations, and maintenance training related primarily to their duties at platoon level, but within the context of company/team operations . Appropriately, no administrative, training management, or logistics and maintenance tasks have been included to prepare new lieutenants to assume battalion staff duties because they are not supposed to be assigned to staff positions, they are to lead platoons.

Officer advanced courses. The Infantry and Armor Advanced Courses (OACs) are designed to train senior First Lieutenants and Captains, usually between their fourth and sixth years of service to command companies or teams, and to serve as battalion S3s (Operations Officers) or brigade assistant S3s. The curriculums and POIs are oriented to meet these objectives . Sufficient detailed instruction is not available to train battalion personnel administration (S1) or logistics and maintenance (S4) duties.

An ARI survey found that the majority of officers surveyed (56% Infantry, 63% Armor) were assigned to staff training earlier than recommended in Army officer professional development policies and guidelines. So even if adequate instruction were part of the POIs, many officers have already filled staff positions. However, only 25 percent of the AOAC officers and 33 percent of the IOAC officers with staff experience felt that these two courses adequately prepared them to perform staff duties. The resulting perception of CTC observers has been that staffs lack the necessary skills and the ability to effectively integrate activities and to synchronize battle planning, preparation, and execution.

The US Army Command and General Staff College trains company grade officers' staff process skills through the CAS3 program. However, no systematic battalion and brigade level staff functional area training exists for maneuver branch officers. Limited opportunities existed in personnel and administration (S1) programs (until 1989), and logistics management (S4) programs. A total of 60 officers are currently trained annually as S4s.

> The ideal staff in the ideal army should be able to take a commander's concept, interpret it, conduct planning and integrate the seven operating systems into a cohesive plan. But, how well prepared are the members of the task force staffs to synchronize the critical elements of combat power? Have they the schooling or background to play their proper role?
>
> *National Training Center (NTC) White Paper, 1989*

Tactical commanders' development course. The Tactical Commanders' Development Course (TCDC) is designed to train battalion and brigade commanders to synchronize battlefield operating systems, to apply tactical doctrine in combat operations. The course is an effective and accepted response to a recognized requirement for brigade and battalion level "how to" synchronization training for planning, preparing, and executing missions. Doctrinal components and the Synchronization Matrix are used extensively during the experiential planning and preparation phases. It is frequently after having accomplished the staff planning and preparation work themselves, using the synchronization matrix, that the officers realize what their staffs are expected to do. However, the development of a specific staff functional training program remains a requirement.

Combat Training Center Findings

Command and staff activities suffer from not only limited training, but from instability as well. The primary staffs observed during fiscal year 90 worked together an average of 4.6 months before a member was transferred. This turnover occurred even with units focusing on stability for their CTC rotation.

Light infantry related observations. In a comprehensive US Army War College Study Project, 11 JRTC battalion Take Home Packages, 11 related Senior Observer/Controller observations, and three quarterly observer controller training observation summary packets were analyzed to assess current tactical performances. A separate study included observations from nine NTC Heavy/Light force mix rotations in a summary of the first Light/Heavy rotation at the JRTC. Another project reported on the findings of an Infantry School team which observed the operations of a Light/Heavy rotation at the NTC. The Directorate of Evaluations and Standardization (DOES), US Army Infantry School reviewed six JRTC rotations. Selected findings from these studies:

>Staff performance problems surfaced not only in the Command and Control Battlefield Operating System (BOS), but across all BOSs.

>There were systemic problems in staff operations in the Command and Control BOS.

>Combat support and combat service support liaison officers required additional training to operate with maneuver branch units.

>Command and control information flow--the synchronization of activities--during planning, preparation, and execution was deficient.

>Many supporting staff elements, especially the Fire Support Officer (FSO) and the engineer, did not integrate their plans with the maneuver plan.

>Fully 60 percent of the battalions and companies had significant difficulty planning for tactical operations.

–A quarter of the battalions reviewed did not develop a scheme of maneuver or articulate a concept of the mission operation for subordinates.

–A similar percentage did not manage time effectively and did not establish work priorities.

–Two thirds had difficulty in preparing and issuing orders.

>Battalions had stressed squad and platoon training at home station to the exclusion of multi-echelon training and the practice of the staff process.

>Units observed either require practice or they were untrained on the clear majority of the command and control and related staff synchronization tasks.

>Battalion commanders and staff officers did not feel that leader and staff training exercises (MAPEX, TEWT, CPX, ARTBASS) were relatively important, nor did they think it was necessary to conduct these exercises frequently.

One implication of these findings is that as a result of limited training and developmental experiences battalion commanders and staff officers lack the perception necessary to assess their true operational capabilities. Most training received by new staff officers has come in the form of OJT experience, both in garrison and in the field.

Training Needs and Interventions. Home station training, no matter how rigorous, apparently can not replicate the conditions that consistently clarify staff performance deficiencies. A clear value of the CTCs is that many command and control deficiencies are only identified in the demanding environment of the CTCs. Units can confirm combat readiness as well as use the CTCs to identify areas needing emphasis during home station training. The CTCs also provide feedback for researchers and training developers.

The downsizing of the Army and reduced resources unfortunately do not make extended residential instruction for all officer advanced courses a viable approach to solving the problem. However, the application of computer based staff functional area and maneuver force doctrinal instruction would prepare combat support and combat service support officers to work more effectively with combat task forces.

Developing battle command staff competencies. One proposal for revamped training programs, labeled Cognitive Role Training, involves straightforward instruction designed to inform participants about the requirements and duties of all battle staff roles. The individual should be trained to perform assigned staff duties as well as know how that position is integrated into the rest of the command and staff activities. Part of the training concept is providing performance based training designed to provide knowledge of:

–staff organization and functions,
–organizational competence,
–organizational process,
–the relationships between organizational competence and the processes most likely performed by staff position,
–staff teamwork and command expectations.

Individual job proficiency is seen as the primary step in developing competent, integrated staffs. In the battle command concept, control could erroneously be interpreted simply as routine, reactive duties. In fact, the successful execution of control requires the same leadership competencies as does command (FM 22-100, 1990). While immersed in battle staff duties, officers develop the two primary elements of battle command, decision making and leadership.

Decision making and tactical judgment are required of staff officers to develop courses of action for the commander. Good staff work means anticipating and planning for requirements and contingencies. This means possessing the battle command skills of thinking and leading within the staff. Battle command competencies can be introduced in institutional training settings, but they can only be assimilated through practical application in unit settings. Future commanders learn the strengths and weaknesses of soldiers and equipment, an appreciation for the time required to plan, prepare, and synchronize the execution of operations only through practice as staff officers in the field. The commander who makes sound tactical judgments does so based in large measure on solid experience. The flexible leader often learns flexibility through experience on staff.

It was repeatedly observed during ARI's BATTLESTAFF research that staff officers gave a low value to the importance of their duties in comparison to command. Company grade officers who were interviewed typically served in staff positions in battalions until they

could gain a company command. On the other hand, US Army War College students, battalion commanders during Desert Storm, commented in recent discussions that a wide variety of assignments, not just command assignments, had prepared them for battle command. We need to help provide the structure for younger officers to understand the learning potential of other-than-command jobs.

The company grade officers interviewed too frequently displayed assertive, competitive behaviors that they thought would make them appear appropriately aggressive for early selection to command. These behaviors were not compatible with effective staff integration, but rather carried subtle competition into staff activities. Ancillary staff competencies, such as intentional cooperation and selfless collaboration instead of competitiveness must be taught and sensed as valued by the commander and the Army for effective implementation of the battle command concept. Staff officers must be functionally competent, well versed with staff processes, and recognize that cooperation is not only appropriate but necessary in many staff positions.

3. FUTURE RESEARCH CHALLENGES

> ...digital communications technology will produce higher levels of situational awareness and corresponding lower levels of chaos and ambiguity. Improved technology, coupled with officers trained in the concepts of battle command and battle space, will transform the Army.
>
> *Maggart and Fontenot Mil Review Feb '94*

OVERVIEW

In this paper we have provided a brief overview of some current research findings on aspects of decision making and leadership, the components of battle command. This research was not conducted as a consolidated, integrated program of research; rather it developed over time in four different ARI Research Units in response to a variety of questions and concerns from many different proponents.

The primary theme of our current research is the importance of understanding the fundamental cognitive processes which underlie both battle command decision making and leadership. Based on what we know to date about those processes, it is clear that the major long term challenge is development of our future battle commanders. The knowledge, skills, and attitudes necessary for effective battle command do not just happen, they develop over time. Furthermore, someone deficient in knowledge or skills will obtain only limited help from, and in fact will probably be overwhelmed by, the information technologies to be fielded in Force XXI.

A second theme of current research is that the sole focus must not be on the individual battle commander, but rather must include both the commander and supporting staff, themselves future battle commanders.

The intellectual power of the army has been brought to bear on the transition of doctrine and training from an obsession with control to a focus on battle command in tomorrow's Force XXI. A typical question posed to ARI is "What is the impact of battlefield digitization on battle command?" The research discussed here cannot directly answer that question. However, the concepts presented here are critical to a systematic look at the important human dimensions of such questions. Our intent is: (a) to continue to develop our fundamental knowledge about knowledge, expertise, modes of cognition, development of group and individual skills, and the supporting research, measurement, and training methods ; and also (b) to provide continuing support to the Battle Labs and other TRADOC and Army organizations which are on the leading edge of the Army's transition. We discuss each of these aspects of our program below, and then conclude this paper with a brief presentation of INSIGHTs gained from this examination of the human dimensions of battle command.

NEAR-TERM RESEARCH SUPPORT

The Battle Command Battle Laboratory (BCBL) at Fort Leavenworth recently completed a successful Advanced Warfighting Experiment (AWE) in conjunction with Exercise Prairie Warrior. Earlier this spring, Focused Rotations at the National Training Center (NTC) addressed issues of battlefield digitization and battle command. ARI was deeply involved in all of these events, and we see future AWEs and Focused Rotations as an opportunity to obtain valuable information while testing some of our concepts.

In the BCBL AWE, for example, we addressed the issue of the impact of battlefield digitization on commanders' thought processes; we specifically addressed the types of decisions made and the decision-making style of the commanders. This was, at best, a small scale case study, not a full-blown research project. We brought to bear two methodological approaches developed in previous research: our Army Command and Control Evaluation System (ACCES) methodology for examining the overall command decision process, and our critical incident observation/interview methodology for obtaining descriptive information on two of the division-level commanders. Data analysis is still underway; feedback from the researchers involved is that our data will provide insights and "value added" to BCBL observations.

In discussions with the BCBL, we have identified several topic areas where ongoing ARI research and studies can mesh with and support BCBL projects, including the FY95 Prairie Warrior AWE.

>Battlefield visualization and communication. We have developed measures and predictors of these skills, and have developed preliminary recommendations for training and for performance aids. The AWE would provide an opportunity to begin the validation of the measures and predictors and to conduct a pilot test of one or more training approaches.

>Models of battlefield problem solving. Ongoing research is identifying and classifying a range of possible approaches to problem solving; observation in AWE or other exercises would begin the process of narrowing that list of possibilities down to the smaller set of approaches and strategies actually used by military officers.

>Development of battle command expertise. While not a substitute for a longitudinal development study, we can gain some insights on the development of battle commanders' thinking skills and knowledge by interviewing and observing current battle commanders at several echelons.

>Battle-command decision training. Recent work on identifying the dimensions of battle command expertise provided some suggestions for approaches to training and practicing decision skills. We are seeking support for an extension of that project to further explore the suggestions, and would use the AWE as one pilot test.

>Other cognitive skills. On-going projects are addressing approaches to the training of skills in tactical pattern recognition and tactical situation assessment. Preliminary results and recommendations will be available from this research in FY95; a pilot implementation of recommended training procedures within CGSOC and the BCBL AWE could provide an assessment of the recommended cognitive skill training procedures.

>Measures of battle tempo. The ACCES methodology lends itself to descriptive data on parameters of the decision process, to include battle tempo. Based on our ACCES results from the FY94 AWE, we expect to be able to provide refined measures of this aspect of the decision situation.

>Effects of battlefield digitization. We propose a follow-up to this year's AWE look at the commander, with a broader look at the impact of digitization on the design of the command structure.

Any one of these projects could easily consume all available resources; under current fiscal

conditions it is impossible to do all of this in one year. Further discussions with BCBL will refine the projects and provide priorities and determination of appropriate level of effort.

These examples focus on work with the Fort Leavenworth BCBL; however, they provide a model which will be used by other elements of ARI working with other Battle Labs. In this way we will stay in touch with current thinking about battle command and related issues, while at the same time passing on and trying out emerging ideas and recommendations.

CONTINUING RESEARCH CHALLENGES

The following section is a slightly edited extract from a paper presented at a Tri-Service meeting in June, 1993. The theme of the meeting was C2 Research Challenges[7]; two years later, the challenges remain with us.

In the following discussion of research challenges, the term "C2" does not refer to a unitary command-and-control process, but rather refers to the complex battle command + control processes. In this broad sense of the phrase, we believe that C2 fundamentally involves individuals and groups trying to understand and deal with a very complex, rapidly changing, set of circumstances. The people involved follow procedures, use information, manipulate information with various tools, draw on their background and expertise to make sense of the information, and share their INSIGHTs with others.

We cannot achieve battle command Nirvana merely by putting more computers and communicators into the command posts, nor by linking all existing and future computers into a local, regional, or even a global "grid". Rather, to achieve battle command success, we would need to:

>know how to design the perfect organization, one which is completely adaptable to internal circumstances (the range of skills, knowledge and abilities of people available, the changing working relationships among those people, the current status of those people including their training, motivation, and levels of fatigue, the quality and volume of information available, etc.) as well as external circumstances (the level and intensity of the threat, the difficulty of achieving the unit's objectives, etc.);

>know how to design the perfect set of procedures for the individuals to follow that will make them as efficient and effective as possible at accomplishing their tasks;

>know how to train in order to develop the necessary skills and implement the necessary procedures (individual AND group)

>know enough about how people process information to be able to design the necessary tools and systems to avoid errors and the loss of time when dealing with information;

>know enough about how people work together to make sure that the organizational design, procedures development, training development, and systems design provide products which are optimized for the most effective performance by the commander and staff as a whole.

Given research already underway or planned for the near future, over the next five years we will gain some new INSIGHTs into the ways people use information to try and understand the situation faced by their unit. We will develop suggestions for new training procedures and new tools to help them do this job better. We will begin to understand some of differences between "experts" and "novices" in this domain of battle command, and will use that understanding to suggest alternative sets of tools to help the novice act more like an expert, and/or alternative training methods to help the novice more quickly become an expert. We will have a mature measurement system for taking the pulse of C2 in a CPX environment, and the

[7]Halpin, Stanley M. Command and Control Research Challenges. Joint Directors of Laboratories 1993 Symposium on Command and Control Research, June 28-29, 1993. pp. 11-15.

beginnings of a database which will support analysis of meaningful battle command performance data. With this as a background, the research challenges in the 5-15 year time frame are:

>How can we mesh the skills of individuals into effective groups? One aspect of this is the set of procedures to follow; we need to know more about the proper balance between individual initiative and group coordination when, for example, developing a complex tactical plan under time pressure. Even without an "optimal" set of procedural rules, we still should address three other aspects of this question:

– the process of training people to work effectively together in problem solving groups;

–the design of (computer based) tools to support cooperative work;

–the design of effective organizations (optimal size and mix of knowledge and skills).

>How can we tell how well the process is working? We need continued development of performance measures which provide indices on process and product quality, and continued efforts to develop and refine performance databases and the tools that make such databases usable. One obvious goal is to enable many people to better understand what battle command is all about, with their understanding based on realistic data. But there is also a less obvious possible spin-off. If we can develop the tools which will enable an analyst to study the records of a CPX and develop an understanding of what occurred in that exercise, then we are a very small step away from the design of a set of tools which would support battle commanders or the battle commanders' staffs when they examine **current** data and develop an understanding of what is occurring right now.

>How can we translate all that we know and learn about the "proper" procedures into effective, ongoing training programs? We need to give renewed attention to questions of staff and unit training strategies. One issue here is the proper balance between staff-cell training vs. full blown unit CPXs. But when that is put in the context of a training cycle, we are looking at a question not just of the balance, but also of the sequencing of different forms of training. One interesting challenge would be to answer the following question: "Over the next year I have this package of resources (time, training facilities, etc.) available for Division A, and this package of resources for Division B; what is the best use of those resources in order to improve those divisions' ability to command and control?" To address these questions, we need to relearn for decision-making groups the lessons we have learned about individuals: i.e., what are the factors affecting skill acquisition, retention, and decay?

>Even when we develop a better understanding of training strategies appropriate for passing on decision making and leadership knowledge and skills, we will still need continued attention to the training process. Here we are referring to the "nuts-and-bolts" issues: for example, what can we do to refine current approaches, such as the use of after action reviews (AARs)? Are there alternate forms of AARs which may do a better job of enhancing learning? What are the skill and knowledge requirements for those presenting the AARs? What is the relationship between established training objectives and training outcomes? Can we help the Trainer do a better job of selecting the proper type and number of training objectives for a given training audience?

>Continued attention to individual tasks and functions, and the systems and training needed to support the individual. Most of our attention, and the rest of the community's, has been and will continue to be on the situation assessment, understanding, planning, coordinating end of the spectrum. But we also need to look at execution. What does an individual need in order to do a good job in executing a battle plan?

INSIGHTS ON THE HUMAN DIMENSIONS OF BATTLE COMMAND

Throughout this paper we have made a number of comments and assertions, put forward hypotheses, drawn conclusions from data, and made recommendations for actions to be taken by the R&D or DTLOMS proponents. In this section we have gathered together many of these INSIGHTs.

COGNITION

Thinking, reasoning, and deciding

INSIGHT: Battle command requires complex thinking of the highest kind, yet there seems to be little intentional effort to determine what these cognitive skills are or how they can be amplified in the Army's officer population.

Source: Observation

Discussion: Perhaps the most critical asset that battle commanders have is their ability to think, yet there is no identifiable program of instruction in the Army to develop more fruitful ways of thought. Commanders and staffs are taught procedures like the Estimate to guide thought. They acquire knowledge in the form of facts (like weapon ranges), rules (like adequate force ratios for defense), and principles (like mass, simplicity, surprise). They are not formally instructed in ways of thinking, reasoning, and deciding (though many of the procedures are analytical and deductive).

We cannot be sure of the extent to which a battle commander's way of thinking could be or should be changed or enhanced. We need to understand far more about how battle commanders do think, so we can know what to train. Reasoning is too critical to be ignored or simply relegated to chance.

What next:? The need is to conduct research to identify ways of thinking, reasoning, and deciding. One approach will be to look for the variability in the population of leaders and future leaders and potential shortcomings of various styles. Research will need to pay close attention to whether adult tendencies can be modified. How much training is necessary to replace or enhance skills that are used in everyday thinking and have been developed over a lifetime? Findings will be applied to prototype programs of instruction and to self-assessment and development programs.

Knowledge and Experience

INSIGHT: Knowledge is fundamental. There is no substitute for technical domain knowledge in proficient battle command.

Source: Recent cognitive theories, general findings on expertise, Focused Rotation observations.

Discussion: Without sufficient knowledge, tactical reasoning procedures can only provide routine, mechanical deduction; not the abduction and assimilation that are required. The notional experience-time relationship (of FM 101-5) implies that more time can substitute for less experience. This is over simplified.

What next?: Continue to emphasize the technical proficiency of battle command. Drop the notion that additional time for decision making is an equal substitute for knowledge and experience. Reinforce domain knowledge by incorporating into all appropriate aspects of Army training (e.g., as has been done in CAS3 by developing problem solving procedures to be practiced in a low intensity conflict scenario).

Situation Assessment

INSIGHT: Effective situation assessment requires a rich mixture of extensive experience, pattern recognition, and other cognitive skills. Many decisions made by experts occur instantaneously. Such decisions are possible because of abilities to quickly visualize, size up a situation, and understand what is happening, and what should be done about it.

Source: Cognitive theory, decision making studies, operator (pilot) performance studies

Discussion. Recognition-based decision models emphasize the skills for understanding a situation, determining whether it is familiar, assessing the stakes involved, and how much time is available to decide. A larger proportion of training and procedures should emphasize situation assessment and visualization skills. These cognitive skills are in contrast to the typical deductive analytic and decision procedures that are taught.

What next?: The cognitive skills for situation assessment (being identified through current research) need to be transformed into cognitive skill training techniques and incorporated into officer education programs.

Problem identification

INSIGHT: Problem solving frequently suffers from poor problem identification, the result is that the wrong problem is solved.

Source: Observation, psychological literature

Discussion: An example of solving the wrong problem is frequently seen when a plan or an order is derived from the unit's mission statement without first developing a complete understanding of the commander's intent. Available problems or easily solved problems are addressed instead of taking the initiative when the opportunity affords itself. The solution with a known outcome is preferred over one that is unfamiliar but may provide a better outcome.

What next?: Increase training and mentoring on problem identification and definition. Combine techniques for problem definition with better techniques for generating options.

Commander's intent

INSIGHT: The concept and role of Commander's Intent is poorly understood.

Source: Observation, BCTP WFXs, curriculum development, Commander interviews

Discussion: Commander's intent is not a single paragraph in a plan or order, but the commander's evolving vision of what needs to be accomplished. Discussions about commander's intent seem too often to center around what the definition is, what the elements of the intent statement are, and how long the intent statement should be. This is an academic view of commander's intent. Commander's intent is critical in a doctrine of maximum initiative to subordinate commanders and in a climate of non-traditional missions and operations other than war.

What next?: Need to determine the efficiencies and limitations in shared understanding and how interpersonal communications impacts it. By determining the ways in which tactical intent is understood and misunderstood, training programs can be developed that will teach efficient, reliable means of communication.

Problem Solving

INSIGHT: "One size fits all" does not apply to problem solving techniques.

Source: Recent decision making theory ("naturalistic decision making") and findings

Discussion: Trying to force the use of a single method for all problems leads to inefficient problem solving, the perception that the procedure is more important than the solution, and ineffective solutions. Institutional training that teaches single problem solving methods or tactical decision making procedures is counter-productive for situations in which those methods do not apply.

What next?: Develop procedures and training for problem solvers to recognize relevant problem characteristics (like the novelty of a problem, the amount of time available, the necessary accuracy, and the extent of required effort). Research needs to determine a range of appropriate methods for problem solving and their effectiveness given various situations.

Planning

INSIGHT: Tactical planning is difficult requiring anticipation of uncertain enemy action and synchronization of multi-level forces. There is little explicit instruction in the Army on how to think to do planning or how to plan when faced with uncertain or missing information.

Source: Research and observation at CTCs.

Discussion: Battle command probably places greater demands on cognitive skill for planning than for decisions. Planning how to accomplish an operation may be more difficult than deciding what to do. There are few teaching materials available for planning.

What next?: Research needs to develop precise concepts for planning based on human tendencies and limitations. Training approaches are needed that are responsive to these concepts.

Management of Thought

INSIGHT: Thinking-reasoning-deciding resources are critical for complex, time-pressured battle command. The management of both the individual and group forms of these "resources" can be improved by the application of metacognitive techniques.

Source: Current cognitive theories, focused rotations, tactical decision making studies

Discussion: Over one-third of the topics addressed in one battalion CPX were interrupted and were unintentionally never returned to for resolution. Such a large amount of effort should not be wasted because of poor work management skills.

What next?: Research needs to identify the explicit metacognitive skills of experts and determine how best to train individuals to monitor and regulate their own thought processes. For example, these skills relate to how an individual or group identifies what to do, the importance of the problems, and how much time to allocate for resolution. These are the same skills that can be applied to the management of group processes. The need is to develop usable knowledge and tools for implementing these techniques.

Tacit knowledge

INSIGHT: The tacit knowledge held by military leaders places less emphasis on self-

management, learning from others, and envisioning the future than does tacit knowledge of civilian managers.

Source: Ongoing ARI/USMA research on tacit knowledge

Discussion: Tacit knowledge is an important part of practical, intelligent behavior because it helps people adapt to, select and shape one's external environment. Tacit knowledge can play an important role in modifying one's behavior to meet the requirements of that environment.

What next?: Continuing research is expected to elaborate on these findings and to make explicit many areas of unstated--but valuable--practices of military leaders. The collection of tacit knowledge may be used to provide vicarious experience and decrease time to become a proficient leader.

Commanders' styles

INSIGHT: There is no single best way to lead soldiers, no single best way to make decisions, no single best way to reason about problems.

Source: Prairie Warrior, ongoing research

Discussion: We often hear about identifying the "expert's" decision or leadership style as if there is some unique set of traits that should be held by all leaders. We work with personality inventories that propose diametrically opposed characteristics; , an individual is said to be either intuitive or analytical, when there is no reason that that person can't be good at both. Tagging individuals with such ill-defined, general labels as *intuitive*, *risk-averse*, or *impulsive* over-simplifies the richness of behavior and the circumstances under which behaviors are displayed. We need to be cautious about the labels we apply to the styles of decision making and leadership. Any specific style should not be seen as a liability, but as an added resource to use for a capable, adaptable organization.

What next?: Current theories of style differences seem to offer little utility other than a fragile label on an individual. More sophisticated models of styles are needed to better understand the interactions beyond the current unidimensional or bi-polar "types" of individuals. Better identification of meaningful styles will allow for better teamwork, staff organization, and problem solving.

METHODS

Measurement of Expertise

INSIGHT: Measurement and standards of complex decision making and intangible leadership qualities will continue to be difficult problems in the development and selection of experts and the exploration and verification of improvement techniques.

Source: Observation, shortage of good measures and lack of standards

Discussion: If performance differences among levels of expertise cannot be reliably distinguished, then we will not know the varieties and qualities of proficient battle command. Without standards for comparison, the training, personnel, and research communities will not know whether expertise is improving or not.

What next?: Need continued development of measurement of battle command performance and the qualities that may contribute to or help distinguish among levels of proficiency or different command styles.

Lessons Learned from CTC

INSIGHT: Data from CTC rotations can not only be used for analyzing a variety of issues such as force design, sustainment, readiness, etc. but may also be used to provide a training benefit to other than the participating unit.

Source: Army leader recommendations, ongoing research

Discussion: Nowhere short of combat is there any better opportunity to understand how total Army systems and organizations work than at the combat training centers. One obvious application is to enable many people to better understand what battle command is all about, with their understanding based on realistic data.

What next?: CTC data need to be in a form that are applicable to issues unanticipated at the time of collection. CTC databases are needed that are easy to access, are non-evaluative (objective), are supportive of training and training feedback, and are low cost. If the tools can be developed that will enable an analyst to study the records of a rotation and develop an understanding of what occurred, then we are a very small step away from the design of a set of tools which would allow battle commanders or their staffs to examine current data and develop an understanding of what is occurring right now. Similarly means might be developed to provide remote audiences with the displays or interactive devices for parallel training to take place.

TRAINING

Training strategies

INSIGHT: We need to give renewed attention to questions of staff and unit training strategies.

Source: Observation, expertise research

Discussion: One issue here is the proper balance between staff-cell training versus full blown unit command post exercises. When that is put in the context of a training cycle, we are looking at a question not just of balance, but also of the sequencing of different forms of training.

What next?: We need to relearn for decision-making groups the lessons we have learned about individuals, i.e., what are the factors affecting skill acquisition, retention, and decay?

Training materials

INSIGHT: Technology is consuming training funds at the cost of attention to the content and quality of what should be learned.

Source: Observation

Discussion: Strategies for training battle command tend to be focused on the delivery systems for the training, while giving disproportionate attention to what the education and training systems should deliver in terms of the end result of soldiers' knowledge, skills, and performance. The Army should be proud of its accomplishments in the application of simulations, semi-automated forces, and remote site link-ups, but it appears that new technology is used to train the same things. We shouldn't automatically assume that advanced computerized technologies (satellite communications, instrumented maneuver areas, large automated war games) are the desirable and appropriate delivery means.

What next?: A concerted effort is needed to reflect on what is being trained in battle command. TRADOC's study initiatives like the focused rotation are doing this. An assessment is needed of low-cost techniques for training tactical decision making processes and exercising thinking and reasoning skills. A half hour exercise

around a situation map conducted by a battalion commander for his staff each week may pay greater dividends than a week-long computer-run CPX.

Training management

INSIGHT: Even when we develop a better understanding of training strategies appropriate for passing on decision making and leadership knowledge and skills, we still need continued attention to the management of training, such as the use of after action reviews (AARs).

Source: Observation, previous training research

Discussion: If there is no benefit received from training because of problems with management, then the opportunity is wasted. The Army cannot afford wasted funds for training.

What next?: Conduct research aimed at answering questions such as: Are there alternate forms of AARs which may do a better job of enhancing learning?, What are the skill and knowledge requirements for those presenting the AARs?, What is the relationship between established training objectives and training outcomes? Estimate the practical aspects of how much training is required, when, where, and the required resources.

PERSONAL DEVELOPMENT

Motivation

INSIGHT: Motivation to learn from every appropriate opportunity is inherent to the development of expertise.

Source: General findings on expertise and creativity, studies on tactical decision making expertise

Discussion: Experts in general find the pursuit of excellence rewarding and tolerate the tedium required to become highly proficient at their craft. There is no reason to expect that battle command is any different than other areas of expertise, in this regard. Learning is not something that just takes place in formal educational and training settings. Learning should occur whenever an individual works at a problem. Even with a high level of knowledge and skills, an individual still may not be effective without the will and desire to succeed.

What next?: Initiate research to determine how to sensitize officers to assess what they know and what they can learn individually from any experience (e.g. self-discovery during a BCTP exercise). Develop instructional materials for independent study (self-development) (e.g., Marine Gazette's tactical decision games, Armor magazine's former "How would you do it?" column, or computer bulletin boards).

Reflection and introspection

INSIGHT: While education, training, and experience are important elements in the development of a leader, these alone are not sufficient. Reflection and introspection are also essential to the development of expertise.

Source: Observation, learning theory

Discussion: Expertise requires intensive periods of study and apprenticeship. Individuals without the skills or capacity to reflect, to understand, to integrate and synthesize new experience and knowledge with previously held knowledge will not grow and progress.

What next?: Conduct research to determine how successful battle commanders use introspection, and in what form, about what, when.

Officer Assignment

INSIGHT: Assignments outside of traditional "command tracks" may be critical for Battle command success.

Source: AWC interviews, observation.

Discussion: Expanding Army missions increases the value of varied experience. If other-than-command tracks are important for battle command, then assignment progression needs to be re-looked. It may be important to evaluate officers' acquired capabilities rather than to assume capability based on specific experiences.

What next?: Need longitudinal research to examine career paths and influences. In the short term, look at the impact on leader development of variations from traditional paths, e.g. SAMS.

LEADERSHIP

Leader competencies

INSIGHT: Leader competencies are often thought to consist of individual styles and styles of interaction with others. While such skills are important, another way to view leadership competency is as an extension of the same problem solving abilities used for addressing tactical problems.

Source: Survey of general officers, general research on strategic leadership.

Discussion: Cognitive skills provide an alternate view of leadership competencies and an alternate way to direct the improvement of leadership. Improving cognitive skills, (such as situation assessment, problem identification, testing of assumptions, mental simulation, planning, metacognition, etc.) can help develop leaders that can quickly size up a situation, find the right problem, and resolve conflicts.

What next?: Investigate the generalizability of cognitive skills from general decision making to leadership. Assess which cognitive skills contribute most to leadership and which are most apt to be responsive to improvement. Incorporate findings into leader development programs.

Leadership and staffs

INSIGHT: Leadership must imbue a sense of intentional cooperation and selfless collaboration.

Source: Staff surveys

Discussion: Interviewed officers frequently demonstrated assertive, competitive behaviors that were counter to shared goals and effort. Training has not prepared staff officers adequately.

What next?: Emphasize to leaders the dangers of an overly competitive staff atmosphere, so that leaders are attuned to monitor the degree of teamwork and lead by example in their interactions with their peers.

ORGANIZATIONS

Adaptive organizations

INSIGHT: All sections of higher level command staffs are not equally employed throughout the preparation, planning, and execution of a mission.

Source: Focused rotations, BCTP WFX, observation

Discussion: Staff organizations that are adaptive to the demands of the job (analogous to adaptive air crews for AWACS) allow leaner staffs. Adaptive organizations may well also be more effective as there is overlap in terms of the

personnel performing interrelated tasks. Individuals involved in future planning might be rotated to assist in the coordination, monitoring, and controlling for the execution phase.

What next?: Explore various ways in which organizations and staffs could be adaptive, on the basis of what situational characteristics, and the ways in which to manage and train adaptive control.

AUTOMATION SUPPORT

Decision support

INSIGHT: Computer-based information systems and decision aids are developed from a technology-centered perspective instead of a commander-centered one.

Source: NATO Research Study Group 19, observations and evaluations of developing systems.

Discussion: Allocation of functions between systems and humans needs to be a deliberate process, matching the functions to optimize the relative strengths of computers (precision, large storage) and humans (adaptability, insight, learning). Millions of R&D funds have been invested in tactical decision aid development with no useful products. Wasted "technical" experiments can be reduced and technical support finally achieved if greater attention is afforded to thinking-reasoning-deciding.

What next?: Incorporate cognitive task analysis techniques (as described RSG.19) into developments. Transform information systems and decision aid development through requirements for careful study of needed capabilities, consideration of cognitive-based solutions, deliberate evaluation and verification of solutions.

Knowledge vs. Information

INSIGHT: In combat, a commander has a rich, dynamic picture of the battlefield; current uncertainties key the commander to specific items of information needed.

Source: Observation of previous studies, system developments

Discussion: Numerous combat development efforts over the years have attempted to identify the commander's critical information requirements. These efforts come up with similar but different lists, usually indicating that commanders--in the abstract--want to know everything there is to know. When those uncertainties are resolved, the standing information requirements become less important, and new ones arise. It is difficult for traditional data base systems to match the dynamic needs of an experienced commander. The commander's knowledge of a specific situation and dynamic knowledge requirements are critical. Tactical battlefield systems must have flexible data base structures that can adapt to the special requirements in a theater and to evolving requirements for a mission, if the systems are to support the battle commander and his staff.

What next?: In the near-term new, flexible data structures should be incorporated into command information systems. In the longer term, entirely new concepts are called for that would allow a system to adapt to the dynamic knowledge needs of the commander and his staff.

CONCLUSIONS

The above discussion provides an overview of the human dimensions of battle command. A continuing theme throughout the discussion has been that information technology *per se* may be more a part of the battle command problem than of the battle command solution. Marvelous intelligence products were available during Desert Shield and Desert Storm, but the information was in the wrong format at the wrong level of detail to be of much use to the commander in the field. Building bigger pipes so that more data can flow from anywhere to anywhere may facilitate C2 but not battle command; we need to know much more about individual and organizational information use before we open the valves on those pipes or we will be inundating both our commanders and their staffs.

As we began the discussion of our perspective on battle command issues (p. 9 above), we made the following statement:

> From a behavioral science perspective, the issues to be considered in developing and implementing the battle command concept would seem to be the following:
> >What information is required for the commander to make timely, effective tactical decisions?
> >What is the best means of formatting and presenting the necessary information to the commander?
> >What skills and abilities must the commander have to be able to effectively use the information provided?
> >How is the process of leadership transformed by the availability of new technologies?

Questions such as these seem to be based on a premise that adult humans can be represented as simple information processing machines. From this perspective all we need to do is to identify the decision rules and the required decision outputs and we can design the ideal input stream. Furthermore, once we have identified the input stream, it would seem to be a simple matter to identify the decision rules a commander needs to use. However, the complexity of cognitive behavior, particularly experts' cognition, makes an information presentation approach to battle command highly suspect.

While we should not ignore issues of human factors and soldier-machine interface, we also should not forget that the most perfect interface to the most robust information system will be worthless to the battle commander if that information system is irrelevant to the commander's cognitive processes. *The key to effective battle command would seem to be the knowledge the commander has, not the information he receives.* The commander's knowledge base and expertise will shape the information required and the interpretation of the information received. Given normal human variability among experienced, senior personnel with long and varied careers, it is hard to imagine an information system that would suit all commanders.

Thus, there may never be absolute answers to the human factors and information systems design questions; too often we will find that individual, organizational, and environmental characteristics and tactical circumstances will overwhelm our expectations of what is required. Special circumstances, and there will always be unexpected special circumstances, will change battle commanders' requirements, modify their cognitive style, and focus their attention in unexpected ways.

Competent, experienced commanders with a robust repertoire of thinking skills will overcome poorly designed systems, and inaccurate or inappropriate information, They will make decisions and provide leadership for their units no matter how dimly they can see through the fog of war. Interim, approximate, "good enough" answers can be found to improve battle command systems without large investments in information technologies.

However, we need to continue to pursue the answers to fundamental questions such as: How do experienced commanders make their decisions? How can they make best use of the personnel on their staffs? What knowledge, skills, and attitudes should we provide our youngest lieutenants to help them develop into tomorrow's commanders? ARI has made a long-term commitment to this research area, and will continue working to refine the issues, develop the methodologies and measurement tools, capture the data, and provide meaningful, useful recommendations to the battle command community.

> We in the Army recognize that, as we are building for the 21st Century, quality people are the most important element of the force....It is time to redesign the force to better leverage both the power of our people and the power of our technology.
>
> *GEN Sullivan msg 081145Z MAR 94 - Building the force for the 21st Century -- Force XXI*

> During combat, commanders must focus on the human factor. They must assess and strengthen their units as they plan and fight battles. They must accurately gauge which units must lead, which must be replaced, where the effort must be reinforced, and where tenacity or audacity and resulting success can be exploited. When leaders begin to fail, control and direction become ineffective, and the organization falls apart.
>
> *FM22-9 Soldier Performance in Continuous Operations, December, 1991*

> The primary element of command and control is the command element. This is accomplished with knowledge of one another, an understanding of intent, a common level of knowledge in doctrine, and a common heritage of thinking about going to war.
>
> *MG Paul E. Funk, Cdr., 3AD, DESERT STORM*

> Leaders know how to prepare an order complete with annexes and overlays, but we are not proficient on producing clear concise orders under the pressure of time and stress found in combat. ... there is a set of mental processes you have to train on in order to get proficient.
>
> COL Lon E. Maggart, Cdr. 1st BDE, 1ID, DESERT STORM

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